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ROYAL

Geological Society of Cornwall.

THIRTIETH

ANNUAL REPORT

OF THE COUNCIL,

WITH

THE PRESIDENT'S ADDRESS,

AND

PAPERS AND NOTICES

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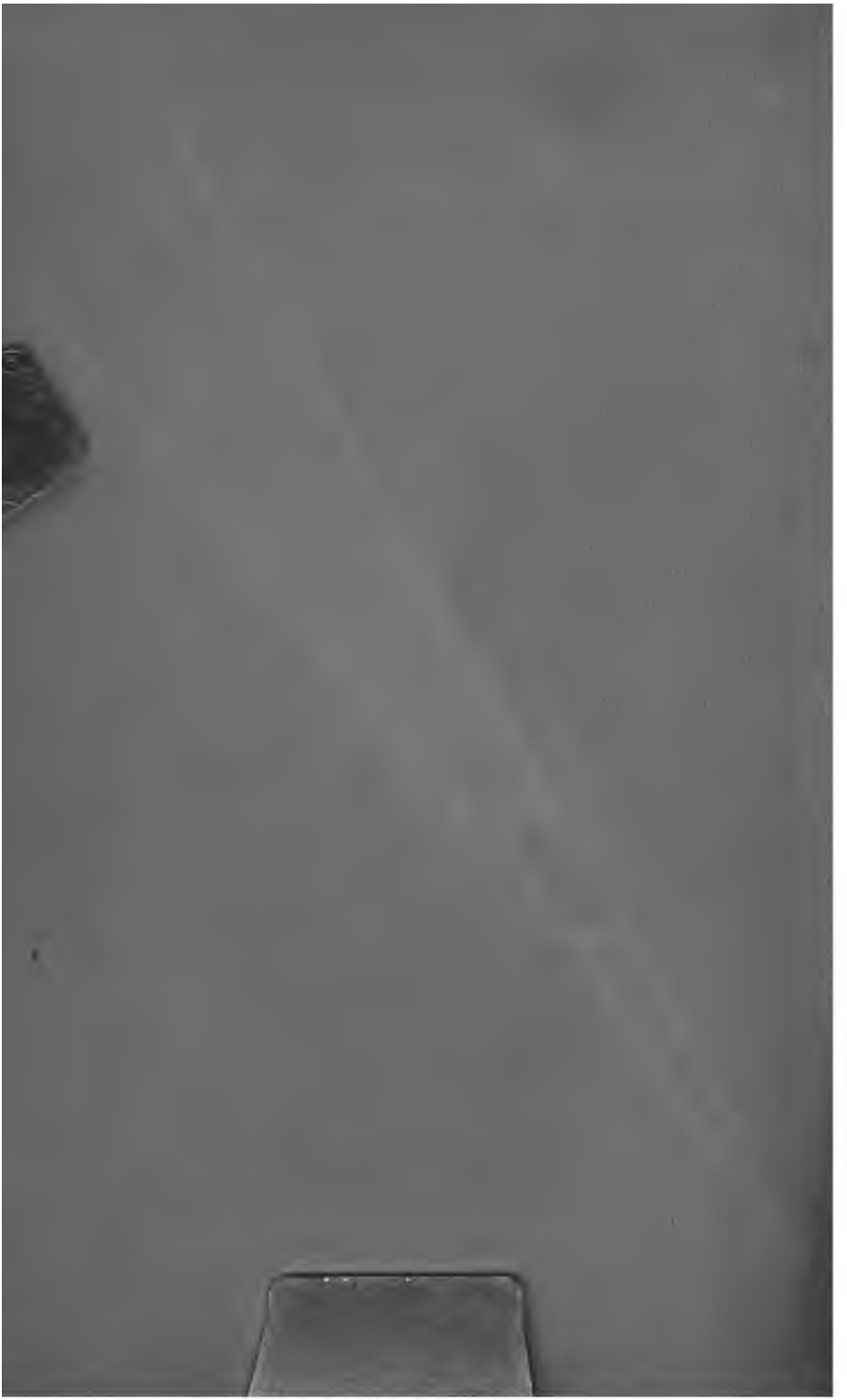

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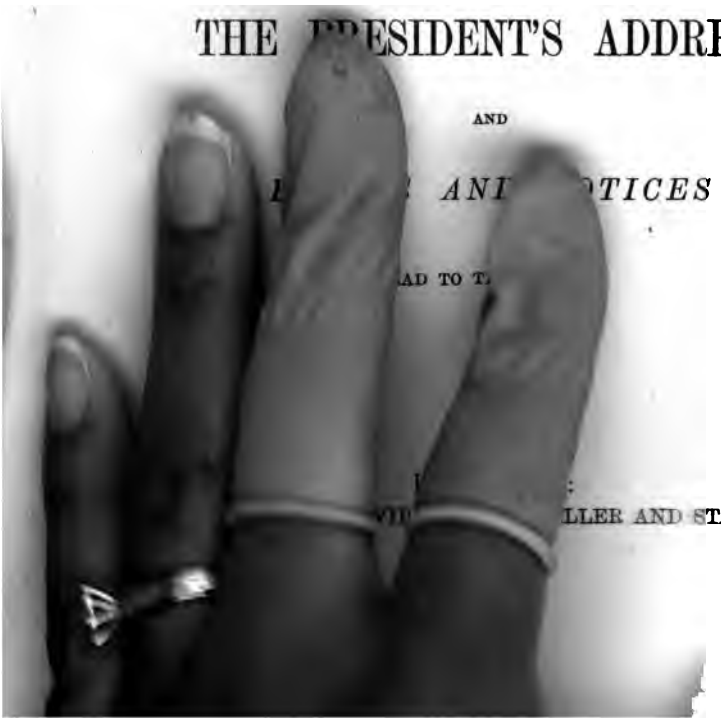

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PRESIDENT'S ADDRESS.

THE second year of our new plan of publication has now closed, and I trust that, if persevered in, it will attract to our Society, not only the attention and good-will of those who properly belong to us, but that it may induce the Geologists of other parts of England to regard our proceedings as the efforts of men labouring in the subordinate but useful and necessary departments of their science, to promote a common object. They have always recognized the Cornish Geological Society as the first offspring of the great Society in London. Its establishment was only the second step in the rise of Geology in England, and its productions have ever been regarded as important contributions to science. I hope and believe that, under the new system which we have adopted, the interest which was at first bestowed on us, but became dormant and almost extinct during the inactivity of our Society, may revive, and place us again in the stream which is now carrying on the science of Geology at such an amazing rate. I think there is already evidence of this returning interest.

The last address of the President of the great Geological Society, delivered on the 17th of February in this year, contains an extract from our report, read in this room only in the autumn preceding; thus proving that words and opinions uttered here have been printed and circulated from hence, and afterwards digested, criticised, and read again in public in a time little exceeding four months. This rapidity of circulation is a very important consideration, which I would press on all those who desire to lay their ideas before the public in a printed form, and with the least possible delay. They may calculate on the certainty that their productions will be in the hands of the great masters of our science before the busy scene arrives when men of science are collected in London, and when the contributions

of provincial Geology are constantly poured into that great reservoir of knowledge.

There are few of these great masters who are not numbered in the list of our honorary members, and they are now, and will continue to be, entitled to our publications as they issue from the press.

If, then, the germ of Geological science still exists amongst us, it will have a convenient opportunity for its development. If it does not exist; if there are not amongst us men inclined to devote a portion of their time to speculative enquiries; if art has superseded science; and if Geological science (our peculiar province) is to be forgotten in the midst of the honourable activity of other branches of human enquiry, why, of course, the opportunities to which I have alluded are of no value; our Society will remain as a monument of former energies and former times; and the best that men can say of it will be—*Olim floruisse audivimus.*

But I have no such presentiment. We have yet some active and valuable contributors; and I have no doubt that their numbers will be increased when the opportunities which this Society offers to those who think on Geological subjects, of bringing their thoughts before the public promptly and in an authentic form, shall be fully understood.

The attempt which has been made to draw the working miners to communicate directly with us has not been successful. The premiums offered especially to them have met with few claimants, and we have yet a sum of £15 in hand unappropriated. I think, therefore, that it is time to modify the plan of premiums, and to make some new experiment with a view of leading the practical men of the county to co-operate with us. It has occurred to me to suggest the following scheme, and I have no doubt that the two gentlemen who concurred with me in the first instance in the offer of premiums, will also concur in some such change of method, by which our object may be obtained.

I would propose, then, that the money in hand should constitute the foundation of a fund for premiums, and that other individuals should be invited to throw in their contributions from time to time as the fund becomes exhausted; but that the Society should annually, out of its surplus revenue, make an addition of £10 to that fund,

and that the Council should be empowered, according to their discretion, to distribute the amount in the manner which they shall consider most beneficial to the Society, and to the science which it cultivates. This latitude will empower them, not only to recompense past services, but to grant assistance to those who require it, to enable them to prosecute their labours for the benefit of the Society. This plan has been very successfully in operation with the British Association; and an instance of its effect may be seen in the sums which have, in two successive years, been voted to our industrious countryman Mr. Peach, and which have enabled him to make very valuable returns to the society which patronised him. We have also great obligations to him; year after year he has added to our collections, and still more to our knowledge, from the fruits of his labours; and I have no doubt that we shall not only pay a just debt, but lay out money with prospective advantage, if we should afford him a little aid to enable him to work more effectually in our service. The British Association have twice voted him £10; I think we should do well to add £5 from our premium fund, as a donation from ourselves in return for what we have received from him, and an incitement to him to persevere in his contributions to us.

Amongst the instruments which the last year has afforded for reasoning on the Geology of our own county, I must put foremost the very extraordinary discoveries which Mr. Peach has made of the remains of those characteristic fossil fish, the absence of which seemed to break the chain of evidence by which our Geological position was to be determined. I know that this absence did not shake the faith of the authors of that system in the conclusion which they had adopted. They rather felt that the peculiar condition of the Cornish killas made it unreasonable to suppose that such evidence would be afforded in this county; and that the high degree of mineralisation of our rocks almost precluded the possibility of organic forms being preserved in them. Sir H. De la Beche insists much on this effect of the changes which our altered rocks have undergone; and this view seems also to agree with the experience of Mr. Griffiths as to the slates of the Devonian system in Ireland, which, he says, in the absence of fossils, can be determined only by position and mineral character.

It is satisfactory, however, to perceive that this link is now supplied. The specimens produced by Mr. Peach before the Geological section of the British Association, are universally admitted to belong to that class of extinct animals which characterise the oldest rocks, be they Devonian or Upper Silurian, in which the remains of vertebrated animals have been discovered; and the evidence of our Geological position is now complete. Mr. Peach will in the course of this meeting read a paper on the subject of his discoveries. He will give his own observations, and show how far the organic remains found by him do or do not correspond with those already described. I wish only to bespeak faith in the statements he is about to make, on account of the credit given to them by the Geologists and Naturalists assembled at Cork.

I believe we shall also hear read a paper by Mr. Edmonds, giving an account of the recent occurrence of a sudden wave, and rush of water on this coast; occasioned, there is every reason to believe, by a violent elevation of the bottom of the sea. This is a very important subject, and possibly may have an extensive bearing on the Geological phenomena which we see around us. We have been in the habit of considering such disturbances of the earth's repose as belonging, with few exceptions, to particular countries, and generally to the neighbourhood of volcanoes; observation, however, has proved that they are common elsewhere.

The committee appointed last year by the British Association to draw up a report on Earthquakes have enumerated no less than thirty distinct shocks in the course of the year, ending on the first of July last, at Comrie, in Perthshire, alone; and have recorded several cases in other parts of Scotland, and at Manchester: we have also in this county experienced several such movements; one of which was plainly felt at Falmouth, and I believe it extended even to this place. This occurred about a year and a half ago.

We have here, then, in this recent instance, an agent at work, having power to produce a sudden elevation of the earth's surface, concealed indeed from our sight, but proved to have occurred by the wave then generated.

Whether or not the surface raised has returned to its former position, we have no means of determining; but it is natural to

suppose that the same power may, in some other instances, have left a permanent change in the level of the coast; elevations or depressions, as the movement upwards or downwards in the oscillations of the strata was in excess. Proofs of permanent elevations we have in abundance, derived from the numerous raised beaches described by Sir H. De la Beche, Mr. Carne, Mr. Fox, Dr. Boase, Mr. Budge, &c.; and from the writings of the former gentleman I gather it to have been his opinion, that the various submerged forests which are found in different parts of our coast, are more probably the effect of internal movements of the earth itself, than of any other cause. This is a very interesting subject, daily acquiring more importance. Mr. Budge has given us very valuable information as to the raised beaches in his neighbourhood; but he seems to have been conscious that he had not exhausted the subject, for he concludes his last paper with these words: "In connection with the raised beaches of "the coast, it is a remarkable proof that from some cause or other "there has been an alternation of sea and dry land over extensive "tracts in this district; but it may still be a question whether these "elevations and depressions of the sea-level have not been of a "local rather than of a general character."

Sir H. De la Beche also leaves it as a point to be determined, whether or not we should treat the several effects of elevation and depression, which he relates as evidence of a general movement operating on a great part of Western Europe, or as a multitude of local movements effected at different times. I think he inclines to the opinion that, within limited districts, the changes noticed have occurred about the same period; still he does not speak confidently as to the connection of any two individual cases.

There is here the thesis of a very interesting disquisition, which I hope Mr. Budge may be induced to follow out; and to prove to us, not merely the extent and situation of the raised beaches which he has remarked, but their mutual connection, the angle which they present to the sea, and perhaps also the direction of the force which has operated to raise them. Possibly he may arrive at some further evidence of the double movement described by Sir H. De la Beche, and insisted on by Mr. Austen as characterising a portion of the coast of Devon.

In the last part of the Geological Transactions, the latter gentleman writes thus: "Within a comparatively recent period, the sur-"face of this part of England was placed at nearly its existing level; "then it was much lower; and it has again been raised to its present "elevation; and these movements must have been recent, because "the shells found in the raised beaches indicate a temperature like "that of the present time."

The same records from which he drew his conclusions are inscribed on our coasts; we have also raised beaches, and a depressed forest; and, further, we have the evidence of stream-works, which he did not possess: and when these are brought fully to bear on the subject, we may find reason to confirm or modify Mr. Austen's assertion, "that the amount of oscillation has been unequal in "different parts of the coast, but the greatest vertical movement did "not much exceed 70 feet; that the whole of the West of England "has experienced similar movements, the amount of elevation in-"creasing from east to west. And we may perhaps infer that such "tracts as the ancient forest beneath Torbay, now permanently sub-"merged, are portions which have not regained their former level."

Sir H. De la Beche computed the maximum elevation in this county to have been 50 feet, and so did Dr. Boase.

A curious instance of such a double movement was brought before the Geological Society in a paper read at one of the early meetings of this season. It appears that there is on the coast of New Holland a submarine forest, the stumps of the trees of which, now converted into stone, have been raised again, so as to project, in some instances, as much as four feet above the sea. Being so completely mineralised, they are not in the same condition as the vegetable remains on our coast; but are rather in the state of those trees figured in a drawing from the Bolton railway, which I had the honour to present to this Society; and they rest on the same formation; namely, the carboniferous slates and sandstones, into which their roots penetrate. It appears, therefore, that after having attained their full growth, they must have been sunk deep in the earth, and remained so long in that position as to have undergone the change of their substance into stone: and as they were finally raised again to a level above that of the sea, we have evidence of their threefold existence, and of their having undergone, at least, two dislocations.

Before I quit the subject of raised land, let me briefly refer to a very interesting lecture delivered this year by Mr. Lyell, in which he brought to bear on this theory a species of proof very rarely to be obtained in Geological reasoning—I mean Historical testimony. He traced from narrated facts of classical times, and from old legal instruments of less ancient date, and also from the evidence of Architecture, the progress of a gradual change of level of a part of the Mediterranean shore, which Geologists had noticed as a fact, but could not bring within the history of man. Mr. Lyell has on the contrary precisely fixed its date, and given a positive value to the comparative chronology of the Geologist.

As I have referred to Mr. Austen's paper, I beg to occupy you for a moment longer, that I may draw your attention to one or two passages in which he states the result of his observations on the granites of Dartmoor. These, he says, bear evident marks of having been protruded at three separate epochs, and are of three distinct ages. I am not aware that the same remark has been made with reference to the granites of Cornwall, which are a prolongation of the same range, and I believe have been considered as identical in substance. A single remark of Dr. Forbes, in the second volume of our Transactions, p. 263, is one of the very few instances in which an attempt has been made by any of our native Geologists to determine the relative ages of our granitic masses. He says, that he observed granite veins penetrating and shifting other veins; thus indicating a second injection of molten matter into crevices in the first mass already consolidated.

I am well aware that it is easy to be misled by these appearances of shifted veins, and Sir H. De la Beche has used much caution in reasoning upon them; but Mr. Austen has adduced several instances where the granite itself has suffered from the violence and disruption which it has inflicted on the superior strata; and he confirms his argument by a reference to the general appearance of the district. This he describes in the following words: "The "general direction of the Axis is about S.W., and N.E.; and we "should naturally find in the undulations of the surface of the "erupted masses a general parallelism, in conformity with this "direction. Such however is not the case; the whole surface

"showing north and south lines of hills, valleys, and watercourses; "a circumstance which suggests that the present outline and con- "figuration of Dartmoor are the result of disturbing causes which "have acted subsequently to its projection."

I know not how far the circumstances occurring in Cornwall may justify us in adopting the conclusion to which Mr. Austen has arrived. The map of Cornwall attests the fact that the general direction of the watershed is at right angles to the axis of the granite range. But I presume that Mr. Austen does not mean to impute the vast interruptions in the great chain of our granite, which has been cut across from north to south, to subsequent movements of the granite mass itself. They seem rather to indicate that when the great effort was made which threw up such lofty mountains of erupted matter, certain obstructions and oppositions of the strata in particular places occurred, which prevented the granite from reaching the surface in one continuous line.

It is worthy of remark that Dr. Boase seems to have observed as a fact that very parallelism in the subordinate features of a granite country which should, according to Mr. Austen, when undisturbed, range beside the principal axis. He says, that the granite of this county may be divided into three ranges parallel to each other, and running N.E. and S.W.; a direction common to the adjacent strata, and to the principal metalliferous veins. He does not infer that the smaller groups had a different origin from the larger ones; and even thinks that there are no good reasons to justify the opinion advanced by Mr. Conybeare, that the granite of Clegga Point had any newer than the common origin. He relates, however, instances where one sort of granite is imbedded in another, presenting appearances similar to those shown in one of Mr. Austen's wood-cuts. As to the parallelism itself, it in no way contradicts Mr. Austen's theory, but may be reconciled with it by the supposition, that the granite of the district to which Dr. Boase's remark applies, was not subject to that second movement which broke up the natural features of the granite country described by Mr. Austen.

In the early part of the present season a paper was read exhibiting some curious views with respect to the formation of granite, and showing that there exists, in the chemical composition of the rock

itself, evidence of its having been formed under different circumstances, and, as the author infers, at different times. He divides it, according to its chemical characters, into two classes. Ancient granite is characterised by an entire absence of magnesia, but abounds in hornblende: potash, soda, and lithia occur in it, but none of the alkaline earths, or metallic substances. Secondary granite, on the other hand, owes its character to the admixture of the components of sedimentary rocks. Thus the absence of mica in its due proportion, and the presence of magnesia, lime, or metallic matter, or the tendency to pass into sienite, are indications of the later rock; and all binary granite, being subordinate to primary granite, is of this class; and thus granites, according to their age, are divided into alkaline, and alkaline-earthy.

According to this theory, the granite of Cornwall and Devon belongs to the later date. But we can obtain no proof of this fact in Cornwall, because we have no means of comparing our granite with rocks less ancient than killas. Mr. Austen on the other hand shows, that the intrusion of the granite of Dartmoor was even subsequent to the carboniferous deposits. Mr. Wallace gives as the characteristic of Cornish granite, the admixture of schorl—of Scotch granite, hornblende. If this theory has any weight whatever, which I do not pretend to determine, we have here three distinct instruments for the discovery of truth as to the relative ages of our granite; the intrusion of granite into granite; the general configuration of its mass; and the nature of its chemical ingredients. Whether or not they are altogether sufficient to chisel out of these rocks a satisfactory and conclusive inference, I leave it in the hands of practical Geologists to determine. But I hope Mr. Carne will pardon me if I bring to his mind that he has heretofore observed much, and written well, on this branch of Geology; and that he would render an essential service to the science which he cultivates if he would again take up the hammer which has been so long on his shelf.

I closed the last Address which I had the honour to read from this place with a letter from Dr. Buckland, calling the attention of the Geologists of Cornwall to the evidence of ancient glaciers which had been discovered in some other parts of England, and in

Scotland, and which might possibly be found here, if sought after. Mr. Murchison, in the Address delivered by him to the Geological Society of London this season, has commented upon this letter, and has given it as his opinion, that it is futile to encourage the idea that such a search could be successful. I do not presume to arbitrate between such men; but as I have lately seen a tract of country in the west of Ireland, whose rocks present a striking appearance of the passage of hard substances over their surface, and the glacial theory offers one mode (perhaps not the right one) of explaining this appearance, I venture once again to bring the subject before you.

The physical conditions of that country are not very different from our own. The geographical and atmospheric circumstances are nearly the same: the rock appears to be a compact killas, not unlike our schistose killas, and probably of the same age; and the mountains, though higher than any found in this country, are not so much higher as to place them out of comparison with some of ours. But they are craggy, sharp, and hard; unlike the rounded knolls which our killas mountains generally show themselves.

I must warn you, however, that I am not a practical Geologist, and am conscious that I am stepping out of my ground in offering anything like original observation. Further, I am totally unacquainted with the country in which Agassiz and others have laboured in constructing their theory.

In many parts of the mountainous districts of Kerry, and the adjoining parts of Cork, the rocks on the sides of the mountains exhibit a most extraordinary appearance of smoothness, and are sometimes marked by grooves, and channels, running in the direction of the valleys which they skirt. But I saw nothing of those moraines, or loose fragmentary accumulations, which usually accompany a glacier.

The questions which force themselves on the mind of any one observing this strange-looking country are these: Is this smoothness the effect of weather? or of what Sir H. De la Beche calls divisional planes, or of planes of stratification? and, are these channels mere water-courses for the rain, and the result of its continual action?

To explain the full meaning of these questions, I think it best to select one single case, and describe the circumstances as they exist; assuming that this one instance may be taken as a type of what occurs elsewhere.

The sugar-loaf mountain near Glengariff is a lofty peak, I suppose about 2,000 feet high, sloping down to Bantry Bay; and along the shore there is a narrow plain, between the bay and the foot of the mountain. The plain is cultivated; but still the rocks show themselves at intervals down to the water's edge. All over the side of the mountain, and on the plain, huge detached masses of rock, similar in material to that of which the mountain is composed, are scattered in great profusion. These often rest on the smooth surface of the living rocks; but are always, as far as I can judge, themselves rough, angular, and unworn by weather or any other agent. The strata are highly inclined, their strike being from the summit of the mountain almost to the nearest part of the bay. The smoothness on their exposed surface, whether edge or side, is very striking; and this character prevails more or less over the whole flank and base of the mountain.

At first sight, one might impute this smoothness to natural disintegration, the operation of weather; but the condition of the boulders seems to contradict this idea. They prove that the graywacke of which they, as well as the whole mountain, are composed, is remarkably enduring, their edges being quite sharp, and the blocks themselves looking as if they had lately been broken off from the mass of which they once formed a part. It is clear then, that unless they have all fallen at a time comparatively recent (for they are all in the same state), the rocks on which they rest must have been subjected to some action which did not affect *them*, and which consequently was not weather.

In a paper read at Cork, Professor Rogers, of America, after saying that all the more extensive revolutions of the earth's crust have involved in some degree the agency of vast earthquake waves, describes the smoothness and furrowed surfaces of rocks, both in Europe and New Holland, as belonging to the action of these waves at different Geological epochs. Here is one way of accounting for the condition of the country which I am describing;

for the detached masses of rock may easily be conceived to have fallen from the summit, after the most violent action of the waves had ceased.

Against this hypothesis may be stated the fact, that I could perceive no such accumulations of rolled fragments, as must have occurred in the eddies of a vast and irregular wave.

Again, I have heard it conjectured that the smooth surface of the existing rocks may have resulted from the slipping away of the rocks which once covered them. But this smoothness is as apparent on the edges of the tilted strata as on the sides; and I do not comprehend how they could have been thus sliced off in the direction of no natural joint, by their own gravity, though assisted by the action of the force which raised the mountain.

Another explanation is the supposition that the mountain was at one time covered with ice, which pressed downwards into the plain in the manner of a glacier, and left a smooth surface behind it, which, from causes which have operated elsewhere, became afterwards exposed.

In the absence of moraines, the evidence is incomplete; still the whole appearance of the scene so forcibly suggests the idea of moving ice, that I cannot altogether reject the hypothesis because one material proof is wanting.

I do not, however, pretend to have a strong opinion on this question; which nevertheless, in all its phases, I think, touches us near enough to be interesting to Cornish Geologists.

Before I conclude this Address, which I am sorry to find has attained a great length, allow me once again to draw your attention to the capital which I hope the Society is about to create for the reward and assistance of those who will work for us. Two subjects suggest themselves to me as very proper for inquiry and for the use of such capital; and I offer them as illustrations of the manner in which the scheme which I have proposed may perhaps operate. It will of course remain with the Council to adopt or reject them; and if they should adopt them, to determine how they will treat them; whether by the offer of a premium to each, or by the tender of assistance to any person who will undertake to pursue the inquiries suggested by us.

Among the objects which appear to me to call for the careful attention of Geologists in this county, I would notice the altered or metamorphic condition of a large portion of our killas.

Sir H. De la Beche has described the extraordinary changes in the mineral character of the schistose rocks as they approach and come in contact with the granite and other igneous rocks. The labours of Mr. Peach have proved to us that our killas, where free from these chemical metamorphoses, is not so barren of organic remains as we had previously imagined. It strikes me that much valuable information might be obtained by patiently tracing those strata in which organic remains are to be found on our coasts, to their junction with the granite; noticing the progress of change of mineral character, and of the disappearance of fossils. Again, I think we shall do well to let it be known that we are willing to recompense any person who will give us a good account of the local relations of yellow and grey copper ore in our mines; stating the depth, and east and west position of these, with respect to each other, in a given lode or lodes; also, whether the containing rocks, or the lodes themselves, have the stain of iron-ochre; and whether the quantity of gossan has been apparently influenced by the nature of such ore.

THE THIRTIETH ANNUAL REPORT OF THE COUNCIL.

THE Council have at length the pleasure of announcing the publication of the fifth volume of the Society's Transactions, which is entirely occupied by Mr. Henwood's papers on the Metalliferous Deposits, &c. of Cornwall and Devon; and when the multitude of facts which he has brought forward, all from his own personal investigation, is considered, it will be admitted that, independently of other obstacles, which have not been few or unimportant, to its earlier publication, the labour and time necessary for an individual to explore so many of the mines of Cornwall, and several of them again and again, in order to test the correctness of his observations, must have included several years. It may now be stated with confidence, that, by this publication, a more extensive and particular description of the veins of Cornwall, as to their contents, metalliferous or otherwise, their bearings, intersections, connection with each other and with the rocks which they intersect, &c., will be laid before the Geological world than has ever before appeared. The number of large tables contained in the volume, the author having considered it necessary to bring the result of several observations into comparison by presenting them in a tabular form, together with the numerous plates, have greatly augmented the expense, and caused the price to be higher than that of either of the preceding volumes. To the public it cannot be less than thirty shillings; but to the members of the Society, for as many copies as they may wish for, the price of each will be twenty-five shillings.

The Council would draw the attention of the Society to a Geological Map, now in the museum, by Mr. Richard Thomas, of Perran, of the large district south of Helston, known by the name of Meneage, which has perhaps never before been surveyed so particularly; it is accompanied by about three hundred specimens of the rocks in that district.

The Council have again to notice the indefatigable labours of Mr. Peach, and also of Mr. R. Q. Couch, in the fossil Geology of Cornwall, especially their discovery of the remains of fossil fish, some of which were exhibited to the British Association at their last meeting. The Society is indebted to them for a series of specimens exhibiting those remains, the discovery of which forms an additional link in the chain which was supposed to exist between a portion of the slate-rocks of Cornwall and those of the Devonian system. The British Association having voted £10 to Mr. Peach to enable him to continue his researches, the Council recommend the addition of £5 from this Society for the same purpose, being convinced that its funds cannot be more usefully expended.

The Society has also been indebted for donations of simple and fossiliferous minerals in the past year to several other zealous friends, the particulars of which will appear in the report of the Curator.

This increase to the collection makes either a larger museum, or some rooms in addition to the present, almost indispensable, as a considerable part of the fossiliferous minerals remain in boxes for want of space in the museum to exhibit them. The Council would respectfully impress on their successors that another year ought not to elapse without accomplishing this object.

The Council have again to express their regret that the premiums offered by our President and other members of the Society, for information of new and interesting facts connected with the mines, have not drawn from the agents or from the miners the communications which the Society has been anxious to obtain. They cannot doubt the willingness of the mine agents generally to promote the views of the Society. The reason may perhaps be, that no particular subject has been presented to their investigation. The Council would therefore suggest to the gentlemen who have kindly offered the premiums, to connect them with researches and reports on some particular points, to be submitted to the Council previous to the annual meetings.

By order,

L. R. Willan,
Samuel Pidwell, } *Secretaries.*

Oct. 13th, 1843.

DONATIONS TO THE MUSEUM.

1. Sulphuret of tin, from Carn Brea Mines; slickensides; gossan or earthy oxide of iron through which runs a vein of stilpnosiderite; pinite from an elvan-course in Breage. By John Garby, Esq.
2. Copper ore from Shropshire. By M. Le Faux.
3. Saxicava rugosa and corals in limestone, steatite from Kynance Cove, specimens of altered slate, specimens of turbinolopsis, orthis, &c., from Padstow harbour, from the fossiliferous slate of St. Saviour, Polruan, and from Gerrans Bay. By N. Whitley, Esq., Truro.
4. Remains of fossil fish from Polperro and other neighbouring localities. By R. Q. Couch, Esq.
5. Remains of fossil fish. By C. W. Peach, Esq.
6. Pitchblende, from Wheal Providence. By Capt. Penberthy.
7. Sulphuret of lead in gossan; carbonate, sulphate, and black sulphuret of lead; compact supersulphuret of lead rich in silver; muriate of silver; black sulphuret of silver and copper, from the Sark Silver mines. By Mr. John Prince.
8. Calc spar with copper, from the serpentine formation near Pedn Boar Point. By the Rev. Edward Budge.
9. Granite, from Mont Maddo Quarries, Jersey. By Miss Mary Millett.
10. Arseniate of cobalt, and vitreous copper ore, from Wheal Trenwith, St. Ives. By Edwin Ley, Esq.
11. Vein of schorl rock in granite. By J. N. R. Millett, Esq.
12. Three hundred specimens illustrative of the geological structure of the district of Meneage. By Richard Thomas, Esq.

DONATIONS TO THE LIBRARY.

1. Transactions and Proceedings of the American Philosophical Society. By the society.
2. Journal of the Bombay Branch of the Royal Asiatic Society. By the editor.
3. Mr. Murchison's Address, delivered at the anniversary meeting of the Geological Society of London. By the author.
4. Bulletin de la Société Geologique de France. By the society.
5. Transactions and Proceedings of the Geological Society of London. By the society.
6. Reports of the Natural History Society of Northumberland, Durham, and Newcastle-on-Tyne. By the society.
7. Report of the Truro Institution. By the institution.
8. Mr. Hunt's Essay on Thermography. By the author.
9. Professor Owen's Memoir on the Mylodon. By the author.
10. Memoires et Bulletin de l'Academie Royale de Bruxelles. By the academy.
11. The Mining Journal, from October, 1842, to October, 1843. By the editor.
12. M. Schwann's Memoir sur les Phenoménes periodiques de l'Homme. By the author.
13. Report of the 12th Meeting of the British Association for the Advancement of Science. By the association.
14. Tenth Annual Report of the Royal Cornwall Polytechnic Society. By the society.
15. Memoires de la Société de Physiques and de l'Histoire Naturelle de Genève. By the society.

16. A Geological Map of the District of Meneage, with an elevation view of the Cliff at Aust, in Gloucestershire. By Mr. Richard Thomas.
17. Plan of the Sark Silver Mines. By Mr. John Prince.
18. A Section of the west side of Clegga Head. By Mr. Whitley.
19. Annual Report of the Royal Institution of Cornwall. By the institution.

TREASURER'S ACCOUNT.

Receipts.	£	*s.*	*d.*
To Balance from last year	141	18	4
Subscription from His Royal Highness the Prince of Wales	20	0	0
Donation from His Royal Highness Prince Albert	10	10	0
Subscriptions received from Ordinary Members	58	16	0
	£231	4	4

Disbursements.	£	*s.*	*d.*
By Rent of the Society's House	31	10	0
Housekeeper	5	5	0
Taxes	2	18	6
Printing the last Report	5	19	0
Insurance	3	3	6
Advertising	2	19	6
Coal	4	3	0
Carpenter's work	2	14	5
Repairs and alterations of the Stove, Rain-gauge, Barometers, &c.	3	12	6
Sundry petty expenses paid by the Treasurer and Secretary in two years	5	16	6
Glazing and Painting	1	9	0
Stationery, Periodicals, &c.	9	2	2
Balance in favour of the Society	152	11	3
	£231	4	4

On the Fossil Fishes of Cornwall.

By CHARLES WILLIAM PEACH, Esq., F.G.S.,

CORRESPONDING MEMBER OF THE SOCIETY.

In the Address of Sir Charles Lemon at the last annual meeting, published in the twenty-ninth Report of the Society, I find the following notice of a most interesting work, which I have since read with a most heart and soul sympathy with the author. The observation I particularly allude to, as connected with my subject, will be found in the latter part of the quotation: "Within the last "few months a book has issued from the press, the title of which "is, 'The Old Red Sandstone.' I think it ought to be in our "library; because, though no traces of the strange animals there "described have yet been found in this county, we live within their "domain." I feel it a high happiness now to be able to say with certainty, that we do "live within their domain," and that the remains of these "strange animals" have been found in our rocks.

I have long been of opinion that fish remains were embedded in the Cornish rocks, and at the meeting of the British Association for the advancement of science, held at Plymouth in 1841, I publicly stated that opinion. In my paper published in the twenty-eighth Report of the Society, will be found, at page 16, under the heading of "Ready Money Cove," the following words: "Possibly fishes;" and again, under the head "Polruan," at page 18—"Portions of fishes, and specimens of a plant-like "appearance."

At that time, the specimens I produced were very obscure; still to me they were valuable, as connected with other forms which I noticed in the rocks, and which, from their delicacy, and the friable nature of the matrix in which they were embedded, could not be removed. Thus the fossil fish of Cornwall were firmly

fixed in my mind, and in fancy floated before my eyes, and I felt a great desire to convince others that they existed not only in fancy, but in reality; but little did I think that the proof which I now have the pleasure of laying before the Society would be of such a triumphant character, or so complete, for complete it is; and I have the gratification of saying, that some of the most distinguished Geologists of the present day have pronounced the specimens produced beautiful and good ones, and that they belong to the fossil fishes of a very ancient date.

Some time since I received from the Messrs. Couch, Surgeons, of Polperro, in a letter, two or three small specimens of fossils, which they thought to be coral; and in my acknowledgment of the receipt, I gave it as my opinion that they were fish bones. I mention this in order to give those gentlemen the full credit of being the first to notice these organic remains in the rocks of their neighbourhood.

On the 20th of June last I visited Polperro, and, accompanied by Mr. R. Q. Couch, went into Scilly cove chang on the east side of the harbour, where, to my great delight, lay exposed before me a magnificent fish-bone bed, which extends from this spot to beyond Talland sand eastward, and from thence to the entrance of Fowey harbour westward.

These identical rocks are described in Messrs. Sedgwick and Murchison's paper, in the fifth volume (new series) of the Transactions of the Geological Society—"On the Physical Structure and "Older Stratified Rocks of Devonshire," as follows:—"At the "entrance of Polparrow harbour, the coarser quartzose beds are "overlaid by a beautiful rock, with a perfect transverse cleavage, "producing a fine striped slate. The beds dip north, at a great "angle, while the cleavage planes dip also north, but at a much "smaller angle. . . . . As the same prevailing northern dip "is continued to the mouth of Fowey river, it is obvious that the "beds above described are inferior to the fossiliferous group."*

I make this quotation to show, that notwithstanding the idea then entertained of the "inferior position of these rocks, from the

* Page 665.

supposition of their being non-fossiliferous, they must now be placed differently, for the fossils are found in those rocks with the "transverse cleavage," and in the *slaty* rocks, from the top to the bottom of the cliffs, in the various layers exposed—generally on the under side: in some places they are very abundant. Most of them are of a beautiful shining jet black, and have that enamelled appearance and granulous structure, mentioned both by Murchison and Miller, as peculiar to the fishes of the "old red sandstone."

I have been able to identify the following as agreeing with those figured in Murchison's "Silurian Remains:" at present they appear only in "mangled forms," but quite characteristic, and of sufficient plainness, so that, as far as *pictures* and *reality* can be compared, they are one and the same.

I find belonging to the "old red sandstone" part of the lateral horn of *Cephalaspis Lyellii* (Agassiz, Pl. i.); scales of ditto; portions of other descriptions of *Cephalaspis; Ctenacanthus ornatus* (Agassiz, Pl. ii., fig. 14); scales, &c. of *Holoptychus nobilissimus* (Agassiz, Pl. ii., bis.); with the shells *Bellerophon* and *Turnitella;* besides others not well defined.

Of the upper Ludlow rocks, there are, portions of the skin or shagreen of the *Sphagodes* (Pl. iv., figs. 1 to 4); *Onchus Murchisoni* (Pl. iv., figs. 10 and 11); also portions of teeth, and probably coprolites.

Some of the above are also mentioned by Miller.

Besides these, there are several others differing in many respects. I would particularly mention one which appears to be part of a spine: it is again covered with spine-like processes, which give it the appearance of a crocketed pinnacle of a church tower. Another beautiful spine is most delicately striated: the striæ are again divided, where a portion of the outer covering is removed.

Some of the scales of the *Cephalaspis* are round, others rhomboidal, and some like those described in Miller (Pl. vi. vii. & viii.) as lozenge-shaped: there are also specimens, the scales of which, instead of being like any of the above mentioned, are long, and have each end divided into a pyramidal form, locking alternately with the adjoining scales, into those forming the next row. Some other specimens also differ: one which appears to belong to a rather

large fish is covered with tubercles in wave-like rows. These, with others, I have in my possession; and I have no doubt, if time permitted me to search closely, this list might be greatly extended. At Fowey, in Ready Money Cove, I have found part of an *Onchus*, and other remains; and at Polruan, fragments of bones, and portions of plants: I have also noticed portions of fishes from the Gribbon, near Menabilly, to Mellendreth beyond East Looe, but nowhere are they so abundant as near Polperro.

On the northern coast, in Lower St. Columb Porth, where I had a very short search, I got a portion of (apparently) an *Onchus*, and a tolerable specimen of a *Bellerophon;* this latter circumstance is interesting, as it shows that the fish-beds extend through the county.

I forbear to enter into a minute description of the rocks of Polperro, they having been so lately and accurately described by Messrs. Murchison and Sedgwick, and still later by Sir. H. De la Beche, in the Ordnance Geological Survey. I shall only remark that they contain great quantities of volcanic matter, the eruption of which is supposed to have been the cause of the sudden destruction of the tenants of the ancient seas.

Although my business is only with the fish remains, I cannot resist the temptation of mentioning that at Giggan Cove there is an extensive fault, which has thrown the strata into great confusion: here there is a large vein of limestone of a greyish colour, exceedingly hard and compact, several feet in width, which contains portions of fishes, and specimens of the *Bellerophon*, &c.; it shows itself again at Old Island, and Lake Rock, where it is several yards in width, and encloses great quantities of nodules, traversed by veins of calcareous spar very much like Septaria: here the organic remains are very indistinct: from this spot the vein may be traced across the beach to Rotterdam, into the cliffs on the eastern side of Talland Sand.

Notwithstanding the discovery of the one thing (viz., fish remains) deemed to be needful in order to our having "a name and "a habitation" in the Geological scale, we are still, it seems, doomed to be nameless; for although Mr. Murchison, at Cork, said "that these fish remains appear to belong to the upper silurian, "the oldest rocks in which the remains of any vertebrated

"animals have been discovered, and that they occur in rocks "forming the axis of South Devon, which he had always con- "sidered the oldest in the country"—and Mr. Phillips regarded them "as equally related to the carboniferous and silurian forms, "and probably belonging to an intermediate position parallel with "the cornstones of Herefordshire"—we are still to remain in an unsettled state. When men so high and celebrated in the science of geology shrink from the task of christening our rocks, it would be presumption in such an humble individual as myself to attempt to do so: we must therefore "bide our time," working on in right good earnest, and endeavouring to bring forward such evidence as will prove our true position, and force them to give *positively* what they now advance so *cautiously*. Leaving the matter in their hands for the present, I shall return to my home with a full determination on every opportunity with "pick and gad" to rip the rocks and exhume the long-entombed remains of by-gone ages, and place them in situations where they may be viewed, and made use of for the benefit of science; and should I be fortunate enough to bring forward what may still further advance the tide of truth, it will add to the pleasure I have so often experienced when a new wonder has been laid open before me; and as I have the happiness of knowing that new and useful helpmates are in the field, with whose labours I am delighted, I can only say, "Go on; let us neither rest "nor be weary, until we have attained our end."

A Sketch of the Origin of Mining Laws in Europe.

By the late JOHN HAWKINS, Esq.

Communicated by Sir CHARLES LEMON, Bart., M.P., F.R.S., &c.,

PRESIDENT OF THE SOCIETY.

The following remarks were sent to me by Mr. Hawkins, when I had a work in hand which was afterwards set aside. I allude to the time when the project was on foot to restore the Antient Stannary Courts, and to make such alterations in the laws which they administer as the present state of mining might require. It occurred to me that some knowledge of the laws of other countries might then be of use; and Mr. Hawkins was kind enough to assist me in acquiring that knowledge, by giving me, as a foundation, a sketch of the mining laws under the Roman Empire, and at subsequent times, which he had prepared for another purpose, but not published. Everything from his pen is valuable; and as I had his full permission to make use of his remarks as I thought proper, and have now the sanction of his family to the same effect, I do not scruple to lay before the society, in his own words, this very interesting survey of the antient codes from which the present mining laws of the different countries of Europe have sprung.

Charles Lemon.

It being expedient to observe some order in the arrangement of this information, I have made choice of that which is suggested by a chronological view of the subject, and this has made it difficult for me to avoid throwing the whole into an historical form, although in connecting the facts before me, you may be disposed to think that I have taken some liberties, which it was by no means my intention to do.

I presume it is not your object to go farther back into the history of mining than the period of the Roman Empire; but it is of no small importance to your inquiry, to ascertain in what light mines were considered at that period, for in the form of government which the Romans established in all the countries which they had subdued, it is not improbable we may still recognize some features of that which now subsists.

The rich mines of Spain, Thrace, and Upper Egypt, when those countries fell into the hands of the Romans, appear to have been regarded as the property of the state, and were farmed out like most other sources of public revenue. They were chiefly mines of gold and silver, the labour of which was performed by slaves and state criminals.*

At a later period there is reason to believe that the obligation of working in the mines was imposed on the inhabitants of the districts in which they were situated, *glebæ et metallis adscripti*, as is the case at present in Siberia and the Turkish empire. This was the condition of the mines in Thrace in the reign of the emperor Valens, when the miners abandoned their works, and joined the victorious Goths.†

Trajan instituted a corporation of mining adventurers, under the denomination of *Collegium aurariorum*, for working the gold mines of Dacia (vide Gebhard's "History of Hungary," where the fact is proved by some Roman inscriptions); and Valentinian the First gave permission to every one to open new mines (of gold and silver?) on consideration of his receiving a certain portion of their produce.‡

As early however as towards the end of the Republic, there are even indications of private persons having been the proprietors of mines;§ and there is reason to believe that this was the case at a much later period.‖

The revenue which was drawn from this source, as well as from salt-works, rivers, forests, and quarries of marble, was appropriated to the Fisc or public treasury, and placed under the administration

* Diod. Sic. v. 28.

† Cod. Theod., lib. 15, and x. titl. 19. Ammianus Marcellinus, xxxi. Cod. Theod. de Metallariis.

‡ Vid. Tit. Cod. Justin. de Metallis. § Strabo, xii. p. 221. Essai sur la Mineralogie des Monts Pyrenees, p. 243.

of the Comes Sacr. Largitionum, subject to whom in the eastern provinces of the empire was a Comes Metallorum. But these were merely officers of the revenue, and appear to have had no jurisdiction over the mines: nor is there reason to suppose that any code of mining laws was ever enacted by the Romans.

How long this impost on the produce of mines continued to be levied we know not; it probably subsisted until the mines partook of the general ruin of the Western Empire during the irruptions of the barbarous nations. The mines being then abandoned, and the Imperial Government at an end, no revenue could have been raised from this source during a period of considerable length.

But when Charlemagne had established something which in regard to its form and extent resembled the old Roman Empire of the west, and it accorded with the policy of the Papal See to sanction the delusion of its revival, there were not wanting some law-writers who supported the claim of the German Emperors to all the Royalties (regalia) which had belonged to the Roman Emperors, among which, as they pretended, was the tenth of all the produce of mines, although it may be observed that Frederic the First was the first who attempted to establish this right in its full extent; Charlemagne having exercised it in respect to such mines only as were situated in his own domains.

Although the tenth of the produce of mines was all that could be fairly claimed on the hypothesis of an uninterrupted succession, yet the mines themselves began at this time to be considered as fiscal property, and they were disposed of in various imperial grants of feoffment to the princes or great vassals of the empire, this assumed right being based on a false interpretation of the Roman law, although it plainly appears that Justinian had regarded the mines, according to the spirit of the more ancient Roman law, as private property, *ad fructus fundi*, the use of which was unrestricted. In fact, his pandects allow of no other interpretation. We learn however from the Codex of Justinian, lib. ix., tit. 6, that there were some ordinances of preceding emperors by which the right of opening mines was granted on the consideration of a certain impost payable to the public Treasury; and although these ordinances are properly to be regarded as exceptions to the general

rule, applied to particular cases, yet some law-writers have nevertheless deduced therefrom an extension of a right of royalty over all mines, following in this respect the doctors of the Bolognian school, who in their time, by means of this interpretation, flattered the ambitious views of the King of Lombardy and Rome, as far as regarded the rights and prerogatives annexed to the Imperial dignity; and the establishment of this doctrine led to the most important modifications of the public law of Germany during the middle ages;* and one of the changes which was thus produced, according to the opinion of Hullmann in his history of the origin of royalties (regalia) in Germany, was the assumption of the imperial right to the royalty of mines, which till then had been exercised as a demainial right, and this in particular instances only, prior to the reign of Frederic the First, but which that emperor first established under the new title of regalia, or royalties, throughout Germany. In short, Hullmann has fully shown, that until the close of the 11th century, in all the instances of mines belonging to that period, which are to be found in public records, and even those which rest on authorities of a later date, *the property in mines was invariably vested in the owners of the soil.*

To this period of freedom in the history of mining may be traced the mining laws of all the states of Germany. These laws were originally the work of free mining associations; suggested by circumstances as they arose; recorded at first in the memories of the old, afterwards digested and committed to writing, and finally revised and confirmed by the several princes who ruled over these states.

The sort of customary or prescriptive legislation here alluded to was not disturbed by the interference of any prince or emperor during the period above-mentioned; for although Charlemagne may have caused the mines in his own demesne to be worked on his own account, as there is reason to believe,† and the Emperor Frederic the First laid claim to the royalty of the mines in all Germany, yet the mining laws which were enacted in those early times were not

* Cons. J. St. Putteri specimen jur. publ. et gent. medii œvi, De instauratione Imp. Roman, sub Car. Magn. et Otton. Magn. facta, ejusque effectibus.

† v. Capitular Car. Mag. de villis, c. 62.

altered or set aside by any positive or direct interference of the emperors; and the German princes forbore to meddle with them till a much later period; when some of these princes, being formally invested by the emperors with the feudal sovereignty over the countries which they had governed in a different capacity, while others had arbitrarily possessed themselves of these rights, they naturally felt a more direct interest than they before had in the management of the mines; and the manner in which they then interfered in mining concerns, as legislators, plainly shows what was the original constitution of these mines: for instance, the oldest written laws of the different states of Germany, on the subject of mines, bear evident marks of the unwritten law of custom or prescription which had previously existed, as well as of their having been collected and compiled before they were ratified and published by these princes.

The most ancient of these were the mining laws of Iglau, a mining town on the confines of Moravia and Bohemia, which are still preserved in some of the public libraries, and which have several times appeared in print. These laws received the confirmation of the King of Bohemia and of the Margraf of Moravia in the years 1248 and 1253; but not before they had been considerably modified and adapted to the feudal form of government which then prevailed. They have served as the basis of all the mining codes which were subsequently compiled for the use of the various states of Germany. It has been remarked that they are drawn up for the most part in a casuistical form, being confined to the decision of particular cases, without reference to the reason of that decision; therefore, it is only by the collation and comparison of many such cases, that we can collect what were the principles of jurisprudence on which these decisions were founded.

The royalty of mines was unquestionably exercised at a period of the history of Europe comparatively early, as a feudal or usufructuary right, although the fiscal exaction of a tenth of the produce of mines may be of an earlier date; for it appears, as I have already stated, on the hypothesis of an uninterrupted continuation of the rights and prerogatives of the Roman emperors.

At present this right of royalty enables the prince who holds it, either *in capite* or by substitution, to open mines in the lands of any of his subjects; but this right does not extend over all minerals whatever, and the rule is, moreover, different in different states: for instance, in Bohemia and Moravia, it extends only over mines of gold or silver; but in most of the Prussian provinces, to almost all minerals whatever.

It follows from this that the landowners, in most cases, are not at liberty to open mines in their own grounds, without the consent of the sovereign. They are nevertheless admitted to a participation of the produce of such mines, and this in certain proportions, which vary according to the nature of that produce, and the particular law of each state: for instance, in some countries, the tenth is equally divided between the prince and the landowner, while of some minerals no portion is claimed by the former. The tenth is likewise modified according to the circumstances of the mine, and sometimes it is wholly relinquished until all the costs are paid.

That the royalty of mines might be rendered more profitable to the sovereign, it was judged expedient at a very early period to confer on miners certain privileges and immunities, which had the effect of encouraging their exertions. Thus all persons were allowed to search for mines wherever they pleased, provided they did no wilful injury to the landowners or occupiers. On the discovery of ore, the first finder, on applying for a lease or sett, obtains it without difficulty, subject however to proper regulations and restrictions. The ground is measured, and in the earliest times the measure was a very limited one, until the period when the deeper adits were driven: it was then judged expedient to enlarge it.

The facility with which the right of opening a new mine is obtained in Germany, reminds us of the Cornish tin-bounds; but there is no other point of resemblance, for the right of pitching bounds in Cornwall is limited to particular lands, and numerous obligations are imposed on the German miner, with a view to secure a fair and effective working of the mines. In Germany, moreover, the measure of ground which is granted to a miner is adapted to the course of the lodes, and is consequently long and narrow; but in Cornwall the bounds are limited by no such rules,

because when they were first instituted, the stream-works appear to have been the sole objects of mining speculation.

As the feudal law was established in England by William the Conqueror, it may be supposed that in Cornwall as well as elsewhere it surperseded all other laws, and it may therefore be inferred that all traces of anterior laws in that country must have disappeared. Nevertheless I cannot help suspecting, that had the law of property in Cornwall been wholly changed by William the Conqueror, we should have found a more extensive signification given to the right of royalty as it regards our mines, and that the free right of searching, as well as the claim of the first discoverer to a grant or sett, would have been as firmly established there as in Germany.

The power of the Duke of Cornwall in this respect is a very limited one, and the natural rights of the landowners throughout a great portion of the Duchy are untouched. They are still *Domini fundi*, and this is a state of things which, in regard to its origin, carries us back to a period antecedent to that of the Conquest.

On Diluvial Action, as exemplified in the Gravel-beds and Sienitic formation of Crousa-Down, in the Parish of St. Keverne.

By the Rev. EDWARD BUDGE,

MEMBER OF THE SOCIETY.

It is well known that this county abounds in evidences of the fact, that at some ancient period its surface has been greatly modified by the action of a disturbed body of water. The huge blocks of stone which lie scattered about over all our downs, and the beds of apparently water-worn gravel which are heaped up in many places, are familiar instances of some of the extraordinary effects that have resulted from an inundation or flood which has left behind it traces of the power and magnitude of its operations. The spot to which this paper refers is one which has hitherto attracted but little observation; and from its lying so much out of the track of tourists, this can scarcely be a matter of wonder. Professor Sedgwick, in his account of the Lizard district, has but barely noticed it; and De la Beche, in his Report, has only given a few lines descriptive of its general features: he considers this as possibly belonging to an epoch anterior to the production of the valleys of the district; and in alluding to the uncertainty of its geological date, he remarks that "this patch of gravel is perfectly isolated, occupies an area of "about half a square mile, at a height of about 360 feet above "the level of the sea, and resembles no other accumulation of "superficial detritus within considerable distances."

In making a few observations on this deposit, my design is to bring it more under the general notice of those who may visit the Lizard district for scientific purposes: and I venture also to think that I shall be following out the track pursued in my two former papers, by noticing more at length some points connected with the locality that I more particularly refer to, which may be worthy of

investigation by all who are interested in the monuments that still remain in our county to attest the nature or extent of former geological changes.

Crousa-Down is an extensive piece of nearly level ground, having a very slight declivity towards the south, and is just on a level with Goonhilly-Down, the Dry-Tree, the highest part of the latter being only about 7 feet higher. On the eastern side, Roscreage Beacon is a point of land a little more elevated, being 380 feet above the level of the sea. About a quarter of a mile distant from the road leading to Coverack are the beds, or sand-pits, as they are familiarly termed, to which I refer. They consist of numerous layers of fine or coarse yellow gravel, alternating with quartz pebbles, but in no very determinate order. These pits having been excavated during many years for different purposes, they exhibit sections to the depth of 10 or 12 feet in some places, and there is reason to believe that they extend downwards much deeper, as beds of a similar though inferior kind have been opened and worked at a lower level on the same Down. Over these beds is an accumulation of black peaty soil of about six inches deep, and the surface, where recently exposed by the cutting of the turf, looks as if it were strewed over with small fragments of quartz, having the same sharpness and freshness as if they had been recently broken and scattered about. In this they present a strange contrast to the rounded pebbles which are below them, looking as if they belonged to a different order of causes, by which in the one case the same substance was rounded, as in the other, was only broken up and splintered.

The evident conclusion to which we are led by looking at these deposits is, that they are the *débris* of some considerable portion of quartz, from which alone pebbles of this kind could have been derived. If they were not reduced to this state of comminution and roundness on the spot where we now find them, they must have been brought here previously to the period when the neighbouring valleys were formed; for it would be impossible to suppose that a mass of this nature should have been rolled up over the hills, instead of being deposited in the valleys that occur in the vicinity of this spot.

Two subjects of inquiry here present themselves; first, From what source have these pebbles and their accompanying sand been derived? and secondly, Can any causes be assigned for their accumulation in this particular place? The first of these inquiries is naturally connected with the quartz formation of this neighbourhood. A little south of the Nare Point, masses of this substance rise a short distance beyond the cliff, and as they are almost directly in the line of strike with the same rock at the Dodman Point, and are precisely the same kind of rock (as I have found by examining specimens sent to me by Mr. Peach), there is reason to conclude it to be a continuation of what we may suppose was once the nucleus of the greywacke and conglomerate formations which enclose it on either side. It is easy to trace this rock stretching from the Nare in a north-westerly direction for several miles. It may be seen occasionally cropping out on the sides of the valleys, and large blocks, economically used as fences, supply a certain index of its course. The largest masses of it are seen at the place I have mentioned near the Nare, and in a deep gorge south-west of Carne, in St. Anthony, where it is at least ten feet in width. In some cases the colour of this rock is white, but frequently it changes to grey, and in the darker shades of that tint it takes the form of a coarse siliceous sandstone. This is the case in the valley leading up from the estuary towards Manaccan. It may here be observed to pass almost by a gradual transition into some of the varieties of conglomerate with which it stands intimately associated. It is therefore no improbable conjecture that this rock, at the period when it was broken up, contributed by its detritus to supply a portion of the fragments which were afterwards accumulated, in the form of rolled pebbles and gravel, in the deposit now under consideration. I do not, however, imagine that more than a portion of it has been thus supplied. The pebbles would have been of larger size, and of greater variety of colour, had they all come from this source. The generality of them are white; some of them as large as a man's head; but, for the most part, they do not exceed two or three inches in length, and most of them are still smaller. Their forms are also very irregular: many look like small flints, and are excessively hard. These I should refer to the great quartzose

formation just mentioned; but the rest I am disposed to consider as the result of much smaller veins, which are characteristic of the greywacke and its kindred formations. All these appear to have undergone extensive degradation and abrasion in different parts of the district, since the period of their first consolidation. The conglomerate of the Nare contains numerous veins of quartz which, like those in the greywacke-slate formation, appear to have been formed by siliceous infiltration, which may account for their being somewhat loosely aggregated in their structure; a circumstance which, combined with oxide of iron percolating through the crevices of the rock by the action of water, renders them extremely liable to disintegrate, and fall out from the mass to which they belong. This circumstance facilitates the ruin of such rocks. We cannot visit any of our beaches in the neighbourhood of the slate formation without being struck with the abundance of white quartzose and other pebbles with which they are covered; a circumstance which especially leads to the conclusion that quartz veins of the class which are usually observed intersecting the schist rocks, were the source from whence the pebbles found in the Crousa-Down gravel-beds were in all probability derived.

To resolve the second question proposed respecting those beds may be a more difficult task. The only inference we can draw from the fact of their being accumulated here in such considerable quantities is, that there must have been particular circumstances, either in the drift of the currents, or in the nature of the ground, which were favourable to such a deposit. To this we must superadd one requisite condition of the problem; viz., rocks of a class abounding in such veins, which could not have been very remote; and indeed we may reasonably think that the space now occupied by our valleys was then filled with such rocks. Now it is easy to conceive that there may have been before the period of this deposit some considerable hollow or depression here, which would have acted as a sort of funnel to absorb the *débris* that was previously washed about in a looser and more dispersed condition. There is nothing to indicate that a lake or estuary once existed on this spot, or we might suppose that this, in combination with a powerful river, were the agents in collecting this mass of gravel, and depositing

the sand and pebbles in the state of beds, as we now find them. The present condition of the sienitic formation will perhaps serve to countenance the opinion, that an extensive excavation of the strata must have here taken place before the period of the gravel deposit. Whatever were the circumstances under which these rocks originated, they must at the first have formed a continuous mass; but they are now, for the most part, in a state of total wreck and separation. The whole line of country, from Porthoustock to Gwinter, a distance of four miles at least, presents a broad band of scattered boulders of that variety of rocks which from its excessive hardness is here termed iron-stone. Mr. Majendie considers this rock to consist of felspar, hornblende, and diallage; but I apprehend that quartz also, in an inferior degree, enters into its composition. If, then, we suppose that these blocks are the remains of a high ridge of sienite rocks, it will be obvious, that when these were swept away from their ancient position, a deep chasm must have been the necessary result of this displacement. It is evident to an observer that none of these blocks to which I refer are *in situ*, unless we suppose that the beds from which they were torn lie buried underneath the deep covering of superficial *débris*, which in most places hides all traces of such beds from view. To a certain extent this probably is the case, for a little to the west of Crousa-Down there is a stratum of what is commonly termed *marle*, but which I found on examination to be sienitic rock, of precisely the same character as the boulders on the Down, only in a state of entire decomposition, which renders it, after a short exposure to the air, fit for agricultural purposes, and makes it a most fertilizing manure, from its containing a due proportion of those earths and alkalies which are so essential to vegetation.

It is curious here to remark (though it would be beside my purpose to explain) how, by a chemical process which is admirably adapted to serve the interests of man, the same rock which we see lying over the surface in unwieldy blocks which encumber the soil, and are remarkable for hardness and intractability, may, by the softening agencies which time and Nature have at command, be made available for the interests of the agriculturalist. I may mention the fact that the owner of these marle-pits (as they are called) has almost a

mine of wealth in such a possession. Thousands of loads are, and may be, sold as manure, and yet, from the depth of the deposit, there is little fear of impoverishment by that which would generally prove a ruinous expedient.

In looking, however, at one of these quarries which I noticed near Trelan, I am led to entertain an idea that this rock, as well as granite, to which it bears a considerable resemblance in some points, was originally formed of different degrees of solidity, and that the harder parts, which we now see scattered about in the form of tors and boulders, are only as it were the kernels of the original mass; and that these, from a more perfect crystallization, or from some other chemical circumstance affecting the compound, have remained, and are still likely to remain, impermeable to atmospheric influences. I am led, therefore, to conjecture, that to some such cause as this we may ascribe the destruction of these masses of sienitic rock which once occupied the crest of Crousa-Down; and I imagine that the marle-pits which I have just noticed are only the outcropping of its deeper beds, which have been more slowly undergoing the same process of decomposition and disintegration, as that which led to the overthrow and dissolution of the upper strata.

We have only then to suppose diluvial action to have been brought to bear upon masses of rock, which were previously disqualified to resist its violent operations, by being but imperfectly consolidated throughout their entire substance. The effect of such an attack of the waters would be to tear up and disperse large portions of them, and in this destruction many of the neighbouring rocks would inevitably share. It is easy also to conceive, that watery disruptions from without may not have been unaccompanied by internal disturbances of a volcanic description.

Upon the whole view of the case, it is hardly possible to avoid the conclusion, that this part of the Lizard district was the focus and centre of those destructive agencies which have strewed the neighbouring Downs with the fragments of ruin and convulsion. The gravel-beds of Crousa must, I imagine, have owed their origin to a period when, by the operation of a terrific power which baffles all conception, huge portions of rock were ejected from their more ancient position, and rolled about among fragments of quartz, upon

which they acted as hammers, to pound them into sand, or to shatter them into fragments. During this season of strife and elemental war, currents would have taken the form of whirlpools; and it is to this cause perhaps that we are to trace the filling up of such a cavity as that we have here supposed, with the floating detritus. Successive agitations and upheavings of the contents of these gravel-beds, after they were once accumulated, would give to the whole that appearance which they now have, of sedimentary substances deposited under circumstances of alternate tranquillity and disturbance. Following out this speculation, I am induced to think that it was at this period that the Raised Beaches of Coverack and other localities along the coast, as well as the tract termed the Lowlands, which I described in my last paper, became invested with the fine covering of sand which now lies over them. This I consider to be the washing down of the finer portions of the scienitic, conglomerate, and hornblende rocks, reduced to a finely comminuted state by diluvial action.

Upon the whole, I conclude that the several circumstances to which I have adverted will suffice to throw some light upon the origin of a deposit which must be allowed to be one of an almost unique character in our county. The facts which I have stated seem to me to harmonize well with one another, and to furnish a most important monument of the revolutions of the earth's surface in past ages. A testimony is also here afforded to the theory of those geologists who have supposed that the range of diluvial currents which swept over the earth at some former period was from north to south; for this is the general direction in which we find the blocks of sienite distributed over the slopes of Crousa-Down. There are blocks, however, of the same stone scattered over Goonhilly-Down in a direction considerably northward and westward of what must have been the limit of the sienitic formation, a fact which, with some others, may serve to show that there was also a reflux as well as a direct current.

If, then, we ascribe to the agency of water the gravel deposits in question—the scooping out of most of our valleys—the levelling of the Goonhilly plateau, and its envelopment with a thick coat of clay derived from the breaking up of the argillaceous strata of the

neighbourhood, and if we add to this the distribution of our stream-tin and manaccanite through the water-courses where they are now found, we shall have a list of diluvial results, all of extraordinary character, and effected within the limits of our county, at one and the same period. It would be disingenuous to conceal the fact that I conceive the great Deluge described in the Book of Genesis to be adequate to explain all such phenomena as those to which I here advert. It may be the fashion of the day (at least it is one of the curious phases of modern science) to pass rather slightingly over an event, upon which the older theorists rested the whole weight of their geological systems. That event which was used formerly to explain everything, is now too apt to be treated as if it were capable of explaining nothing. To avoid these extremes, seems to me to be doing only justice to a science which needs not to encumber itself with fresh difficulties by keeping out of sight one of the most mighty changes which the earth's surface has ever undergone;—a catastrophe, the evidences of which will always be valuable, as they serve to link together divine and human knowledge into one harmonious chain; and impart to scenes that are apparently barren and uninviting, something of that high interest which must attach to the theatre of man's primeval history.

On the Relative Position of the Yellow and Vitreous Sulphurets of Copper in the Lode of Pembroke Mine.

By RICHARD TAYLOR, Esq., F.G.S.

MEMBER OF THE SOCIETY.

I AM induced, by what fell from the President during a conversation with him respecting the local relations of the yellow and grey copper ores in the mines of this county, to offer this brief notice of the very striking difference in the character of the ores contained in the lodes which were formerly worked in Pembroke mine, and now in Boscundle, one of the Charlestown mines, which I have observed as the workings of the mine have advanced westward.

In the eastern part of Pembroke, which is near the cliffs of St. Austell bay, the ore was a strong yellow sulphuret; in the central portion of Pembroke mine, black and grey ores occurred as well as yellow ore. In the western part of the mine, the black and grey ores prevailed, although the mine still produced some yellow sulphuret, particularly where it was worked to the greatest depth.

In Boscundle, which is considerably further west, on the course of the same lodes, some very rich bunches of grey copper, accompanied by black oxide of copper, have been found at shallow levels. Associated with these ores were also yellow sulphurets, containing an unusually high produce of copper, and being thickly coated with grey and black ore. In this locality, however, a still more remarkable change occurs, in the presence of tin in considerable abundance, in some places constituting portions of the lode distinct for those containing copper, but in others intimately mixed with the richest portions of copper ores.

The further progress of the works westward has proved the almost entire diappearance of copper from these lodes, while they have become regularly productive of tin.

The remains of some ancient workings, at a short distance further

west than those recently made, and although still in killas, being on the flank of the granite hill, on the summit of which the celebrated Carclaze tin mine is situated, show no trace of copper, but present the mineral characters which are common in the tin lodes of that district.

Parallel to the lodes which I have here noticed are, on the north-east, Crinnis lodes, and on the south, the very large and rich lode which formerly produced copper in such large quantities in Great Crinnis mine, situated on the cliff of St. Austell bay, and has in later years been extensively worked for tin in Charlestown mines.

I have good reason to believe that changes in the metalliferous contents, very similar to those I have described as occurring in the Pembroke lodes, characterize those which are parallel to them in this locality, but I have not had the same opportunity of tracing them in their whole course.

I may however notice that so completely has the Great Crinnis lode changed its character as it has been explored westward, that in the Charlestown mines I have not found it to contain any copper, except in a few hard specimens, in which very thin flakes of native copper have been found curiously interspersed in hard tin-stone.

I regret that the haste with which I have been obliged to prepare this brief sketch has not allowed me to do more than to notice generally some of the most striking features of this case, as I am aware that, to be of any value, many and precise details are requisite, descriptive of the variety in the earthy mineralization of the veins and of the disturbances in their course occasioned by cross-courses and slides, which in this case are very considerable, as well as of the character of the including rocks.

There is one circumstance which it is right that I should particularly mention, as we are taught by Mr. R. W. Fox to consider it of importance in the explanation of the changes which may have occurred in the metalliferous contents of lodes subsequently to their original deposition; viz., that the killas in contact with those parts of the lodes which contain the grey and black ores, are stained a bright red colour. This is remarkably the case in parts of Pembroke mine, and in Boscundle, but not invariably so; and I am inclined to think that this staining does not extend to any great depth from the surface, even although the veins continue to contain grey ores.

An Account of the Sark Mine, in the Island of Sark.

By Mr. JOHN PRINCE,

Associate of the Society.

This mine is sunk 70 fathoms below the deep adit, and levels are extended 150 fathoms east of Le Pelley's shaft, and 70 fathoms west of Sark's Hope, under the sea. The lode varies in size from 2 to 12 feet, bears nearly E.N.E. and W.S.W., and dips, on an average, 10 degrees northerly. The rock which it traverses is a very hard sienite, except near the lode, where it is decomposed, and in some places chlorite (peach) is found. In these decomposed sienitic and chloritic rocks are numerous steatitic joints, and veins of massive and crystalline carbonate of lime, peroxide of iron, and beds of oxy-hydrate of manganese.

The matrix of the lode consists of fragments of the strata, carbonate of lime, milk, rose, and brown quartz, red, green, and white felspar, and in some places hornstone (capal). The lode, as far down as 40 fathoms below the sea, contains an abundance of brown earthy iron ore or gossan (which, however, is not found in the eastern part of the mine), with nodulated, radiated, argentiferous, arsenical, auriferous, and white and magnetic iron pyrites (mundic). The ores produced are the muriate and sulphuret of silver, and sulphuret of lead, combined more or less with other ingredients hereafter to be mentioned.

The following circumstance occurring in this mine appears to be peculiar, and will perhaps be read with interest.

No silver ores (with the exception of a few crystals of ruby silver) have been found uncombined with lead west of Le Pelley's shaft; whereas the lode east of the shaft contained deposits of rich silver ores without any lead.

Those places in the shallow adit, numbered 1 on the section, produced crystalline carbonate, sulphuret, and sulphate of lead; but the spot numbered 2 in the same level east of the shaft, contained none of these minerals, but muriate of silver (see specimens): this muriate continued to the deep adit level, where it was replaced by black sulphuret of silver and copper, with disintegrated iron pyrites (sandy mundic) not chemically combined. This ore reached the 30 fathoms level, below which we have found sulphuret of silver chemically combined with the sulphurets of copper and antimony, without any pyrites.

The following minerals have been found in the deeper levels of the western part of the mine; viz., sulphato-tri-carbonate of lead, sulphuret of lead, super-sulphuret of lead, black sulphuret of lead (rich in silver), antimoniferous galena, and granular galena. These ores contained from 20 to 85 per cent. of lead, and from 30 to 120 ounces of fine silver to the ton of ore.

The following are my analyses, which will show the relative contents of the ores taken from the undermentioned places:—

No. 1.—Ore from shallow adit west of Le Pelley's shaft, marked 1 in the Section.

Carbonate of lead	30, 50
Sulphuret of lead	20, 38
Silver	0, 12
Carbonate of lime	4, 00
Peroxide of iron	3, 25
Silex	41, 75
	100, 00

No. 2.—Ore from shallow adit east of Le Pelley's shaft marked 2 in the Section.

Muriate of silver	10, 00
Peroxide of iron	1, 75
Carbonate of copper	0, 25
Carbonate of lime	4, 00
Alumina	8, 00
Silex	76, 00
	100, 00

No. 3.—Ore from 50 fathoms level, 40 fathoms west of Sark's Hope shaft.

Lead	65, 00
Silver	0, 25
Antimony	4, 75
Sulphur	12, 00
Lime	12, 00
Carbonic acid	4, 30
Water and loss	1, 70
	100, 00

No. 4.—Ore from 50 fathoms level, 10 fathoms east of Le Pelley's shaft.

Silver	9, 50
Copper	8, 75
Antimony	5, 25
Sulphur	5, 50
Iron	2, 00
Silex	67, 00
Water and loss	2, 00
	100, 00

It is to be remarked, that we have no cross-courses, dykes, or flucans, in any part of the mine, to affect the change to which I have adverted: there is however a manifest difference in the matrix of the lode, as also in the contiguous rock, which I now purpose briefly noticing. I would first observe that the *gossans* in the western part of the mine contain carbonate of lead, with minute grains of the sulphuret, with which a small portion of silver is combined: in these gossans we frequently find nodular iron pyrites, exceedingly hard, which when broken shows a beautiful radiated appearance: fragments of quartz are to be seen here; and on both sides of the lode a considerable quantity of hydrate of manganese. The rock here (in the shallow adit) is a decomposing sienite, which continues down to the 10 fathoms level: from thence to the bottom of the mine chlorite appears, which is traversed by numerous small veins of peroxide of iron and carbonate of lime. It is remarkable, however, that in the *cross-cuts* which have been extended a few feet on both sides of the lode, we have invariably found a hard sienitic rock containing an excess of hornblende, but not the least appearance of either iron or lime.

The lode below the 10 fathoms level consists of chlorite, carbonate of lime, and felspar, with felspar-clay (prian) on the *hanging* wall, and more or less ore on the *foot* wall.

The gossans in the shallow adit east of Le Pelley's shaft contain blue and green carbonate of copper, with muriate of silver, &c. I have frequently seen native sulphur in this part of the mine. This I have also seen in the roof of the level, over the bunch of ore. (See No. 4 in the section.)

There is no material difference respecting the quantity of iron and lime throughout the lode; but a greater abundance of friable (sugary) and angular quartz of various colours is found here, with conglomerated and other earthy matter. *Here is no felspar-clay*, and the ores are formed on the *hanging wall.* The rock is a sienite containing an excess of reddish-brown mica, and hornblende evidently in a decomposing state. It is not traversed by any of those veins so numerous in the western part of the mine.

Remarks on the minor Fractures of Rocks, illustrated by Specimens.

By Mr. NICHOLAS WHITLEY.

It is a question of some interest, whether the minor fractures of rocks have been produced in a similar manner, and are analogous to those which exist on a large scale. The heaves, as they have been called, in the small strings of tin at St. Agnes, have long been known. Sir H. De la Beche appears to think that there is no analogy between these and the larger dislocations; these "heaves," he says, "being nothing but numerous *small fragments of slates*, "the results of the minor fractures produced during a more consi- "derable dislocation, cemented by mineral matter subsequently "introduced."* When a piece of slate is broken, it often separates into rhomboidal figures, being the effect of an imperfect crystallization which it has undergone; and when again cemented by mineral matter, something like a heave might be formed: yet still the regularity in the heaves in the tin stones, and perhaps a previously formed opinion, made me hesitate to assent to the high authority before quoted in this matter; and having observed the minor fractures in several other rocks, it appears to me probable that the same causes which produced fractures and faults on a large scale in the earth's crust, have in like manner, but on a minute scale, produced the minor fractures.

The formation of lodes, and especially sparry cross-courses, is well illustrated by the specimens marked No. 3, in which veins of pure silica cut through the fossil shells. That these veins have been formed by fractures which have afterwards been filled by deposition, will appear by inspecting the fossil shells which are split and thrown apart (see No. 3, at *a*, and the shell in the box); and in some of the veins the process of filling is not yet completed. The great

* Report, p. 316.

Crinnis lode, and the Regency copper-lodes, traverse fossiliferous rocks, and organic remains may be obtained close to their walls.

Nos. 4 and 5 show fractures of another kind—faults; and both in the altered slate and the steatite the faults are very perfect, and precisely similar to those which occur on a larger scale.

In confirmation of the heaves in the tin stones, I send a sketch of some heaves which I copied from a large rock, worn smooth by the action of the sea, on the beach forty or fifty yards north of Porthalla, in St. Keverne.

Riding down the valley, on the south-east of Luxullian, I found a large block of granite which had lately been split for building purposes, and in its centre was a piece of slate about 9 inches square, the lamination of which could be distinctly seen, but it was much altered and indurated (by heat?). The block lay at the bottom of the declivity of the hill, and about sixty or a hundred yards from the brook. I have the pleasure of sending the piece which I broke off. (No. 6.) On searching the rocks in the neighbourhood, and at the cutting near Mr Treffry's viaduct, I found several other pieces; one in particular, which had been rounded by atmospheric influence, and in appearance very like the thigh bone at the joint, projected three inches from a huge block of granite: being harder than the granite in which it was imbedded, it had better assisted decomposition, and thus showed the amount of weathering which the granite had undergone. No. 7 is a specimen of the elvan which runs along the face of the cliff near the Blackhead (the same as the Pentewan stone), in which pieces of slate are in a similar manner imbedded.

These facts appear to be confirmatory of the theory of the igneous origin of granite and elvan, and that they were thrust into the slate in a fluid state, portions of which became entangled in the igneous molten mass.

Notice of the discovery of a quantity of Pitchblende, at the Providence Mines, near St. Ives.

By Captain ISAAC PENBERTHY.

These mines are situated on the declivity of the hill which rises from St. Ives bay. The surface is wholly killas, and the mine is in killas to the depth of 50 fathoms below the adit, where the granite appears in the engine shaft, about 50 fathoms in from the cliff.

There are two lodes in these mines; viz., the south lode, from 6 inches to 2 feet wide, bearing about east and west, and underlying 10 inches in a fathom northwards; and the north or main lode, about two feet wide; both productive of yellow copper ore. These lodes have been explored in several levels, to the depth of 100 fathoms below the adit.

In the south lode the pitchblende first appeared in small quantity in the 20 fathoms level, about 7 fathoms from the intersection of the lode by a cross-course, but the principal part was found just above the 40 fathoms level, about the same distance from the cross-course.

In the main lode, the pitchblende occurred above the 30 fathoms level, under the sea, at a spot where a small vein falls in with the copper lode, but about 200 fathoms in length from the parallel spot where it occurred on the south lode.

The pitchblende occurred in small detached masses, seldom so large as the specimen on the table. The whole quantity raised has been about 3 tons. A part of it has been sold for £20 per ton. If it were all as good as the specimen £40 per ton might be obtained, but the adventurers have an idea that it is worth considerably more; I have heard as much as a shilling per pound.

I have been informed that four to five tons of this substance are annually used as a pigment for giving a very fine yellow colour

to glass and china, and that more would be used if it could be obtained. I am not acquainted with the mode of preparing it for this purpose.

It may be observed that the lodes are poorer for copper where the pitchblende occurs, and that they are not so rich in any ores close to the cross-course as at a little distance from it.

The Providence mines are wrought in almost every level under the sea. The adit is 4 fathoms deep.

The 12	fathoms	level is now	30	fathoms	in length under the sea.
20	„	„	65	„	„
30	„	„	90	„	„
40	„	„	105	„	„
50	„	„	70	„	„
60	„	„	45	„	„
70	„	„	18	„	„
80	„	„	18	„	„
90	„	„	20	„	„

The water of the mine is quite salt, and as much so in the deeper as the shallower levels, but in the deeper parts it has also an irony and bitter taste; it is warmest in the deeper levels. The quantity of water is larger in those parts of the mine which are under the sea than in the other parts. The workmen do not hear the noise of the sea in any of the levels: indeed, it is always found that where the sea breaks on a sandy beach, as it does here, the noise and the concussion are much less than when it breaks against rocks.

Contributions towards a Description of the district of Meneage.

By Mr. RICHARD THOMAS,

CORRESPONDING MEMBER OF THE SOCIETY.

This district comprehends about 58¾ square miles, of which the serpentine occupies about 26, the sienite 6¼, the greenstone and mica slate at the Lizard almost one mile, and the remaining 25½ are slate.

Masses of greenstone, some slaty and some amorphous, abound in that part of the slate formation which is near the serpentine and the sienite, and in the serpentine where it is near the slate; and masses of serpentine are found in sundry places in the slate formation; viz., north of Rosuick, and near Trezebal, Treworgey, and Polkerris. (See specimens Nos. 88, 124, 126, 145.)

The slaty formation which lies on the northern side of the serpentine and sienite, dips towards it in a direction varying between S.E. and S.W., the angle of the dip being variable from 10° to 60° or 70°, the particulars of which are given in the description of the several spots hereinafter referred to. This dip seems to have reference to the granite formation of Constantine on the north, and is a continuation of the general inclination of the slaty strata dipping throughout Cornwall (I believe without exception) from the granite.

Immediately south of Mawgan church, there appears to be a large course of elvan (see Nos. 246, 247, 248, 250) ranging about E.N.E. and W.S.W., and dipping S.S.E., which I have not had an opportunity of tracing further west, nor of examining its connexion with the cliff at Mawgan, and its extension eastward. About half-a-mile northward from this course, there appears to be another which I have only seen near Treverry. (See No. 263.)

The greenstone and mica slate forming the Lizard promontory, dip in the western cliffs E.S.E. 35° to 40°: in the southern cliffs N.E. to E.N.E. 10° to 20°: and in the eastern cliffs N. to N.E. 10° to 20°.

At Cadgwith the strata of greenstone dip N. to N.W. 15° to 30°.

At the cliff at Portreath, where there is a junction of the serpentine and the greenstone, the division is well marked, showing the serpentine overlaying the greenstone at an angle of about 45°. (See No. 26.)

I have been informed there are conglomerate formations in the cliffs near Pennare Point, but I have had no opportunity of seeing them.

On Crousa-Downs, which I believe is between 200 and 300 feet above the level of the sea, and forms a sort of plain, extending over an area of more than a mile east and west, by about a half-a-mile wide (there not being any higher ground in the neighbourhood) many pits have been sunk to the depth of 8 or 10 feet, in which are great numbers of stones of quartz and greenstone which have been more or less rounded, apparently from having been subject to attrition by the action of water: they are generally small, but some among them may be as much as six or seven pounds weight. Another such intermixture of quartz pebbles with the subsoil may be seen on a common half-a-mile north-east of Mayne-ambre in the parish of Crowan.

The serpentine rock is covered by a poor soil, owing probably to the presence of the magnesia which abounds in that stone; but where there are greenstone intersections the soil is better, in proportion to the decomposed greenstone that may exist in it. The sienite is covered by an excellent soil, and by its decomposition it yields a vast quantity of *marl*, which is used for manure, as is also much of the decomposed greenstone in and near the serpentine formation: I believe, however, that the value of these manures varies much, in proportion as the ground which affords them is more or less mixed with, or passing into, serpentine or slate.

The greenstone and micaceous slate formation at the Lizard is accompanied by a very good soil, as almost all the greenstone formations are: much of it is decomposed, and is dug up and carried off for manure.

The slaty grounds are of an ordinary character, and form in general moderately good arable lands, in some places much improved by the intersections of the masses of greenstone.

In the following list and description, the numbers refer to the several spots in the map which were examined, and to the corresponding specimens of the rocks which have been cursorily looked at and described accordingly; but it will be desirable to have a more perfect examination of them by a competent mineralogist, who may be able, among other useful deductions, to ascertain whether or not the several formations may differ in their texture as they approach to or recede from others.

Here follow references to the specimens, and descriptions of the rocks from which they were taken. The paper was accompanied by a geological map of the district.

An Account of an extraordinary Movement of the Sea in Cornwall, in July, 1843, with notices of similar movements in previous years, and also of Earthquakes which have occurred in Cornwall.

By RICHARD EDMONDS, Jun., Esq.

(Read 13th October, 1843.)

As these extraordinary movements of the sea are generally attributed to earthquakes, I will first notice the different earthquakes recorded to have been felt in this county.

The first of which I find any notice is mentioned in the "Gentleman's Magazine"* as having occurred at Falmouth in 1696, but there are no particulars of it.

The second happened on the 15th of July, 1757, and extended above 100 miles, from the Scilly Islands throughout Cornwall as far as Plymouth. A full description of it is given by Borlase in his "Natural History of Cornwall."† He also states that, about eight hours and a half before its occurrence, he observed in the fine sand east of Penzance a number of small hollow basins, from one of which there issued a strong rush of water about the size of a man's wrist, never observed there either before or since. Five days before this shock, a very destructive earthquake took place among the Azores, when several small islets rose from the sea.

The next shock on record‡ was a very slight one at Liskeard, on the 24th of February, 1759, at 10 o'clock p.m., accompanied by "blood-red rays which converged from all parts of the heavens "to one dark point, and disappeared in fifteen minutes."

In 1836, a slight disturbance of the earth was observed in the parishes of Budock and Stithians.||

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* 1750, p. 56. † p. 55. ‡ "Gentleman's Magazine," 1759, p. 143.
|| Mr. Hunt, in the 9th Report of the Cornwall Polytech. Soc.

On the 20th of October, 1837, another slight shock was felt at Camelford, Northhill, and Liskeard, as well as on the borders of Devon.*

In 1839, "a shock is said to have been felt at the Scilly Islands "on the 21st of January."†

The last shock felt in Cornwall took place on the 17th of February, 1842, between eight and nine o'clock a.m., and extended from Manaccan on the south to Cubert on the north, about 25 miles, and from Falmouth on the east to St. Hilary on the west, about 18 miles. This has been already described by Mr. Henwood‡ and Mr. Hunt,‖ but they were not then aware that it had extended so far towards the north and south. At Cubert, the noise and the tremor were similar to what would have been produced by the rapid driving of a carriage close to the house.

In the earthquakes of 1757, 1837, and 1842, the noise heard by the miners underground is variously described; viz., as the falling of the pumping machinery; the crushing together of the mining excavations; the breaking of a studdle (a wooden platform), and the deads (rubbish) being set a running; the falling of a kibble (bucket) down the shaft; the falling of a chain, &c.

The sounds on the surface were compared to thunder; the explosion of gunpowder mills; the discharge of cannon; the fall of a heavy body; the rattling of stones; the falling of a house; the rushing of waggons down an inclined railway, &c.

It is evident, either that the noises heard in the mines and on the surface were really very different, or that they were naturally referred to the accidents of most frequent occurrence in the respective situations of the observers.

The above are the only records of earthquakes in Cornwall with which I am acquainted. I now proceed to the disturbances of the sea in 1755, 1761, 1789, and 1843.

The first of these extraordinary agitations took place on the 1st of November, 1755, about 2 p.m., and four hours and a quarter after the great earthquake of Lisbon. It is fully described by Borlase,§

* Mr. Henwood, "Corn. Geo. Trans." v. p. 141. † Ibid, p. 142. ‡ Ibid, p. 459.
‖ 9th Report Corn. Polytech. Soc.
§ "Nat. Hist." p. 53. "Philos. Trans." vol. 49. p. 373.

who states that at St. Michael's Mount, the sea, when perfectly calm, about half an hour after ebb, suddenly rose and then retired; about ten minutes after it rose again nearly six feet, coming in very rapidly from the south-east: it then ebbed with the same rapidity to the westward, for about ten minutes, until it was nearly six feet lower than before: it then returned again and fell again in the same space of time. The agitation continued for about five hours and a half, and boats were hurried in and out of the pier with an impetuosity not to be resisted. At Penzance pier the sea rose and fell eight feet, coming in from the S.E. and S.S.E.: in Newlyn pier, and at Mousehole, it rose and fell ten feet, and came in from the south. By a vessel in Gwavas lake, it was ascertained, on heaving the log, that even in the decline of the commotion, the sea was running at the rate of seven miles an hour.

In addition to Dr. Borlase's account, I have been informed by two descendants of an eye-witness, that at Lamorna cove, which is on the south-western part of Mount's-bay, the sea on this occasion rushed suddenly towards the shore in vast waves, with such impetuosity, that large rounded blocks of granite from below low-water mark were swept along like pebbles, and many of them deposited far beyond high-water mark. One large block, weighing probably six or eight tons, was borne repeatedly to and fro several feet above the level of high-water, and at length deposited about ten feet above that level in the stream, where it still lies. These boulders had previously formed a barrier which prevented the fine sand from reaching the beach, except in very small quantities, but ever since their removal, it has been deposited in great abundance. This rising of the sea in waves may have been caused by the influx meeting the ebbing tide, which near Lamorna is rather strong; and this supposition agrees with Borlase's statement, that the sea was observed at Newlyn and Mousehole to come in as a wave from the south; for Newlyn, Mousehole, and Lamorna are all on the western arm of the bay, and the ebb tide sets out towards the south-west.

Similar agitations of the sea were observed on the same day, not only in different parts of Great Britain, but in other parts of Europe, in Madeira, and in the West Indies; some of which preceded the earthquake, but most of them followed it.

On the 31st of March, 1761—the day on which, at noon, happened the second great earthquake at Lisbon—another extraordinary oscillation of the sea was observed in Mount's-bay. About five o'clock, p.m., after the tide had ebbed about four hours and a half, on a sudden it advanced to the height which it would have reached an hour and a half before high-water; it then retreated again near to the point of low-water; then it advanced again, and retreated, making five advances and as many recesses in the space of an hour. At Penzance and Newlyn, the sea rose about six feet perpendicular; at St. Michael's Mount, about four feet. At Mousehole pier the sea was in great agitation, and the fishing-boats in danger. At the Scilly Islands the agitation continued more than two hours.*

On the same day an earthquake occurred at Madeira, at twenty-five minutes before noon: a slight shock was also felt in Cork about a quarter after noon.

On the 28th of July following, at 10 a.m., similar fluxes and refluxes occurred in Mount's-bay, Falmouth, Fowey, and Plymouth. The rise in this bay was at first about six feet; and when it had nearly subsided, so that the rise was only about a foot and a half, it was ascertained that the sea occupied seven minutes in flowing and seven minutes in retiring.†

I have been recently informed by three aged persons that in 1789 another such agitation occurred at the Mount and Penzance: at the former place the influx and reflux were so great and so frequent as alternately to float the vessels and leave them dry several times, and under the cliff of Penzance one of my informants saw the sea, at about half-ebb, suddenly rush in sixty or seventy yards and surround a number of mules then passing, so that they were almost compelled to swim. I could not ascertain the day or the month when this occurred.

I come now to the movement of the sea which I witnessed in Mount's-bay on the 5th of July in the present year (1843). It began about noon, when the tide had ebbed an hour and a half. I arrived at Portleven, on the north-eastern part of the bay, an hour after its commencement, and found the inhabitants in a state

* "Philos. Trans." vol. 52, p. 418. † Ibid, p. 507.

of excitement observing the sea, which, in the *interior* of the harbour, was moving up and down in a most unaccountable manner, whilst at the mouth it was as smooth as usual. The *inner* basin of the harbour is about 150 yards long, lying N. and S.; the *outer* part is double that length, and lies W.S.W., opening like the mouth of a bell. The agitation extended about 300 yards from the northern shore of the harbour, but not the least disturbance could be seen in the outer part for a hundred yards within the pier-head. I remained at Portleven above an hour, but, having other engagements, could only watch the movement at intervals. From what I saw, and from what I afterwards heard from the fishermen, it appears that the sea rushed inwards from the middle of the outer harbour along the western arm, rising about four feet, and retired by the eastern arm, occupying between ten and fifteen minutes in the circuit. After a pause of eight or ten minutes, it rushed in and out again in the same manner, and so continued, but with gradually decreasing violence, until low-water. A fisherman came into the harbour in his boat an hour after the commencement of the agitation, and from the calmness of the sea at the pier-head, had no suspicion that there was any run within the pier, until some persons on shore called to him that it was dangerous to land, and presently, as he entered the inner basin, one of the influxes carried his boat along with great impetuosity for a hundred yards towards the northern shore, and retiring, left it dry on the beach.

At Penzance, on the northern and inmost part of the bay, the agitation was not only in the pier, which opens towards the north-east, but likewise behind it for more than a quarter of a mile towards the south and south-west. The eminence on which Penzance stands terminates in a ledge of rocks called the "Battery Rocks," which are dry at low-water. Between these and another rock (60 yards on the east) called "Carn Olver" there is a channel (also dry at low-water), through which two most unusual currents were passing, nearly parallel with each other, and eddying and foaming in a remarkable manner: they reached from the elbow in the back of the pier to beyond the point of the "Battery Rocks," a distance of 400 yards towards the south-west. The eastern current was flowing continually seaward close to "Carn Olver," the

western one moved alternately in and out by the "Battery Rocks." The latter was observed at noon to flow inward from the "Battery Point," and immediately to retire in the same line; this was repeated several times, the influx lasting about ten minutes, and the reflux only half that time. Two young men were then bathing near the "Point;" one of them, who had gone into the water on the western side of the rocks, was, on reaching the "Point," carried inward along the eastern side with such rapidity that, although a good swimmer, he was unable to stem the current, and was for some time afraid that he should never regain the shore; the other, seeing that the current was only ten or twelve yards in breadth, went into it from the eastern side of the rocks, swam across it, and continued to swim on the outside of it around the "Point," until he landed on the western side; he thus ascertained that there was no sensible disturbance beyond twelve or fifteen yards south of the "Battery Point." He also dived to the bottom where the current was from eight to ten feet deep, and found it as strong there as on the surface: he considered its velocity when greatest to be between three and four miles an hour. The agitation continued to increase from noon until half-past twelve; and at one its violence was not at all diminished. In the meantime, within the pier, the sea was observed first to retire suddenly to a considerable distance, and soon afterwards to return, occupying in both movements nearly twenty minutes, and so it continued for two or three hours; whilst at the pier-head there was a most remarkable eddy, which whirled the boats in all directions.

At Newlyn, in the north-west corner of the bay, the sea first fell suddenly about four feet, rushing with a great eddy towards the south, to the distance of half a mile, in a current of about a quarter of a mile in breadth, and then returned in the same state of agitation to its former level. This ebbing and flowing was observed four times successively within about an hour and a half. The large fishing-boats riding at their moorings with their bows toward the wind (then about south) were, during the outward currents, turned towards the north. My informant, a very intelligent fisherman, who went in a boat on the water whilst it was thus oscillating, estimated the average rate of the current at three miles an hour.

At Marazion, three miles east of Penzance, one of the influxes was noticed about one o'clock, when the sea rushed in from the south about fifty yards, to the height of four or five feet, and then retired to its former level, occupying about ten minutes in each movement. Between two and three o'clock, the causeway from Marazion to the Mount was dry, and after more than half-an-hour the central part of it was again covered.

Between Marazion and Penzance, where the water is very shallow, no agitation was remarked.

At Mousehole, on the western arm of the bay, two miles S.W. of Newlyn, there was so great an agitation that one of the large fishing-boats parted its hawser, and was carried out of the pier; but no rise nor fall of the water was noticed.

Mousehole on the west, and Portleven on the east, distant from each other ten miles across the bay, were the limits of the observed disturbance. The tide in this bay rises about twenty feet at the highest springs, during which at low-water all the piers are dry.

During this agitation the sky was overcast with thunder-clouds towards the south-east, and early in the morning a distant thunder-storm had been heard in that direction. In the afternoon, before the agitation had entirely subsided, a storm of wind came on from the south, and almost simultaneously a heavy sea, in which the fishing-boats out at the time had a narrow escape; and the sudden cessation of the wind and sea was as remarkable as their sudden rise.

The weather on the 5th, and throughout the week, was fine, with the exception of an occasional shower, the wind being generally about west; the temperature ranged in the daytime during the week from 56° to 64°. The barometer, at 9 a.m. on the 3rd, was 29.80; on the 4th, 29.77; on the 5th, 29.52 (its minimum this day was 29.50); on the 6th, 29.65; on the 7th, 29.70; and on the 8th, 29.75.

It is remarkable that in the recent disturbance in this bay the agitation of the sea was apparently confined to a short distance from the shore, and at Portleven did not extend even to the pier-head. With a view to account for this, let us suppose that an upward shock takes place at the bottom of the sea, a few leagues from our coast, and that a shoal with one of its sides perpendicular to our

shore is thereby made to vibrate. The shock thus communicated to the water will be transmitted with a velocity much greater than that with which sound travels through air, and may cause the water along the shore to rush up the beach in the same manner as a smart blow at one end of a line of marbles causes the marble at the opposite end to fly off, whilst all the others remain stationary. When this body of water falls back to the stationary or less disturbed part of the sea, it will by the reaction be driven a second time up the beach, and thus the fluxes and refluxes, like the motion of a pendulum, may continue for a long time, although originated by a single shock.

Agitations beginning with an *influx* may be thus accounted for; but they generally commence with an *efflux*, which may be produced by the inclined plane descending from the coast being made to vibrate by a shock upwards; the effect of which would be to drive a considerable body of water seaward.

The irregularity which often attends these oscillations may arise from a subsequent shock interfering with the effects of a preceding one, or from the inequalities of the submarine ground, or from the influence of strong tides.

The concussion of vessels by a submarine shock is oftentimes very great; yet no wave is seen because the motion is too rapid for the formation of a wave, and the surface of the water is (like a rock dashed in pieces by a violent blow) broken into drops, as was seen in Calabria immediately before the earthquake of 1638, when the sea appeared "like a lake in a violent shower of rain covered over "with little bubbles."

The local storms of wind, rain, or lightning, which so often follow earthquakes, may proceed from the disturbance of the earth's electrical equilibrium, produced by its vibration; and in submarine earthquakes they may also, in some measure, be owing to the violent shock communicated to the atmosphere by the sudden jerking up of a large portion of the surface of the sea, which cannot but occasion a considerable aërial disturbance, both mechanical and electrical.

If we now raise our thoughts from the *philosophy*, or *secondary causes*, of earthquakes, to their *Great First Cause*, we must ascribe

it to His mercy, that whilst whole cities and multitudes of the human race have been destroyed by them during the last century, we have only slightly felt them, and have been preserved from their fatal consequences.

About a fortnight after the meeting of the Society, another of these extraordinary movements of the sea occurred in Mount's-bay and Plymouth.

It was observed at Penzance on the evening of the 30th of Oct. (1843), the tide being nearly two hours flood, the sea smooth, and the wind blowing strong from the north-east, with rain. Three persons, who had watched the movement from the pier-head for three-quarters of an hour, informed me that about 5 o'clock the sea suddenly rushed into the harbour, coming round the pier-head from the south-west, and causing a rise in the water of about five feet; it then rushed back in the same line. This occurred three times successively in about forty minutes. A small vessel which lay aground in the pier was suddenly floated and carried out several yards, directly against the wind, and immediately borne in again by the succeeding influx; after which, having been secured by a hawser, she was left aground on her side, and then again floated, twice within half-an-hour.

On the same evening a similar flux and reflux occurred at Plymouth, the velocity of which was estimated by the master of a vessel then lying there, at eight knots an hour.

The thermometer and barometer were respectively, on the—

	Nine o'clock.	Three o'clock.	Nine o'clock.	Wind.
27th of October	49° / 29·50	50° / 29·30	52° / 28·95	S.W. strong gale.
28th „	47° / 29·15	51° / 29·25	45° / 29·30	W.N.W.
29th „	46° / 29·35	52° / 29·35	46° / 29·35	Variable.
30th „	46° / 29·20	51° / 29·10	49° / 29·00	N.E.
31st „	47° / 29·30	52° / 29·30	47° / 29·45	N.E.
1st of November	46° / 29·50	55° / 29·50	49° / 29 54	Variable.
2nd „	49° / 29 63	54° / 29·65	51° / 29·65	Variable.

The minimum observation, therefore, of the barometer (from the 28th of October to the 1st of November) was coincident with the agitation, as was the case also in July last; and while the disturbance in July was accompanied by thunder-clouds, this of October was attended with rain.

This second agitation in 1843 occurred about four months after the first, which is almost exactly the interval between the two agitations in Ilfracombe,* succeeding the great earthquake of 1755, and also between those in Mount's-bay which succeeded the great earthquake of 1761; for in 1843 the interval was *one hundred and seventeen days;* in 1755, *one hundred and eighteen days;* and in 1761, *one hundred and nineteen days.*

My brother, T. R. Edmonds (Actuary of the Legal and General Assurance Society), on reading the preceding paragraph, remarked that 118 days are almost exactly four lunations: and finding that the interval between the earthquake at Guadaloupe, on the 8th of February, and the agitation here on the 5th of July last, was 147 days, or within about half-a-day of five lunations: and also finding that the interval between the two earthquakes in Cornwall, nearest to one another in point of time (viz., those of 15th of July, 1757, and 24th of February, 1759), was 589 days, or within a day of five times four lunations, he was led to continue his inquiry in reference to *all* the shocks of the earth and submarine shocks in Cornwall whose dates are known, as well as the two at Ilfracombe and Guadaloupe, when he ascertained that the interval between any two of the six shocks before that of 1837, or of the five shocks since, has been almost exactly some multiple of a lunation, as will appear from the following tables.

In these tables the dates marked with asterisks are those of agitations of the sea where no shocks were felt; those of the 1st of November, 1755, and the 31st of March, 1761, refer to the agitations of the sea occasioned by the great earthquakes of Lisbon; the remaining dates are those of simple shocks of the earth unaccompanied with such agitations.

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* 1st Nov., 1755, and 27th Feb., 1756.

TABLE I.

(1755—1761, 71 lunations.)

Dates.	Intervals.	
	Days.	Lunations.
1755, November 1st		
1756, February 27th *	118	4·00
1757, July 15th	504	17·07
1759, February 24th	589	19 94
1761, March 31st	766	25·94
1761, July 28th *	119	4·03
Total	2096	70·98

TABLE II.

(1839—1843, 59 lunations.)

Dates.	Intervals.	
	Days.	Lunations.
1839, January 21st		
1842, February 17th	1123	38·03
1843, February 8th	356	12·06
1843, July 5th *	147	4·98
1843, October 30th *	117	3·96
Total	1743	59·03

It may be considered worthy of remark, that at each of the five recent shocks the moon was at or near her first quarter.

As I have in the preceding paper, on several occasions, alluded to the state of the tide, I will here mention that the average time of high-water in Mount's-bay, at new and full moon, is about half-an-hour after four o'clock, or about four hours and a half after the moon's southing; and that the interval between two successive times of high-water is about twelve hours and twenty-four minutes.

On the Killas group of Cornwall and South Devon; its relations to the subordinate formations in Central and North Devon and West Somerset; its natural subdivisions; and its true position in the scale of British strata.

By the Rev. DAVID WILLIAMS,

CORRESPONDING MEMBER OF THE SOCIETY.

I now exhibit to the Society maps, coloured geologically, from Bridgewater in Somersetshire to the Land's End in Cornwall, with a section from the Foreland on the Bristol Channel to Lantioc Bay, east of Fowey on the English Channel, to show the superposition of the Cornish killas with regard to all the subordinate formations with which it is inseparably associated, and the four natural subdivisions into which it resolves itself by characteristic mineral and organic types, which are persistent throughout their entire range. This great and important classification has forced itself upon me by the constant repetition of the same successions in every traverse I have made of the killas country from sea to sea.

The innumerable minute details of strike and dip which I have registered from north to south and from east to west, fully convince me that the Cornish killas in the ascending order crowns a magnificent consecutive series such as I have illustrated on the map and section; a series however (complete and perfect as it is in all its particulars) which manifestly constitutes only a part of some vast system as yet unfolded.

I formerly subdivided the entire group into ten component members, the nethermost of which was the Cannington Park limestone, near Bridgewater; but many circumstances have since induced me to suspect, that though geographically it was associated with the Quantocks, it geologically appertained to the Mendips, and troughed

away towards them, as Mr. Conybeare has long ago suggested.* In this view the foreland or Dunkerry sandstones (No. 2) will provisionally constitute the mineralogical base of the entire system: these are almost identical in mineral composition with the old red sandstone of Monmouthshire and the Mendips, close by, and are, I believe, a more southward prolongation of it. I deny more confidently than ever, that there exists any axis or anticlinal line of fracture in the whole of Exmoor: every geological fact, and all the associated physical evidences, negative such a supposition. The true mechanism of the structure of Exmoor and the Quantocks is, as I announced at Liverpool in 1837, that these red sandstones and shales (hitherto containing only plants), with white quartz, conglomerates, and green compact calcareous grits, emerge from beneath the Linton slates and the other overlying masses, and culminate in three parallel mountain folds with their corresponding inverted flexures or valleys, but are finally lost on the north-east of the Quantocks, where their exposed summits, barely showing through the ridges of the new red sandstone in long, low undulations, indicate them to be rolling away towards the Mendips, the mineral axis of which is old red sandstone, as has been shown long since by Dr. Buckland and Mr. Conybeare.† This view of the true position of the Devonian system; viz., that it occupies an enormous interval between the old red sandstone and the mountain limestone, was first suggested to me about two years ago, on observing in the neighbourhood of Bristol a hard junction between those two formations: subsequently I have been much gratified on finding that Mr. Hopkins and Mr. Daniel Sharpe have, by independent observations at different localities in the north of England, remarked an unconformity also of strike and dip between them. Mr. Hopkins observes, "After the elevation of "the older rocks, including the old red sandstone, the whole district

* "Geology of England and Wales:" Section from the Land's End to the German Ocean.

† It is proper to observe that a thick band of dark blue and oftentimes coarse dull arenaceous limestone is included in these red sandstones in Croyd Hill, near Minehead, and along the east and north-east flank of the Quantocks, very essentially differing from the cornstones or any calcareous beds hitherto described as pertaining to the old red: it commonly contains in its shales and planes of deposition carbonaceous matter oftentimes like powdery coal smut, and as often in extremely thin films with a high metallic lustre: it also contains corals in great abundance, which Mr. Lonsdale recognised as the same species as some others he had described from the lower Palæozoic rocks of South Wales.

"must have been under the sea, and subjected to the powerful "action of denuding causes, by which the up-turned edges of the "disturbed beds were worn to an even surface, and the existing "masses of old red conglomerate washed into the hollows: the "mountain limestone was deposited on the worn and even surface "of these older rocks."* Mr. Hopkins states previously, "The "mountain limestone reposes unconformably on the older forma- "tions, which, within the limestone band, occupy the surface."† At the close of a communication to the "London and Edinburgh Philosophical Journal" for June, 1842, published on the same day Mr. Hopkins' "Memoir" was read at the Geological Society, I indirectly adverted to the views I entertained of the position of the Devon and Cornwall beds; and in an announcement of them at the meeting of the British Association, held at Manchester in the same month, I was constrained to invoke an elevation and submergence of the old red sandstone prior to the deposition of the mountain limestone, to as great and perhaps greater extent than was contended for by Mr. Hopkins.‡ Mr. Sharpe has also observed an unconformity of strike and dip between the old red sandstone and mountain limestone above Kirkby Lonsdale, the angle of dip varying five degrees, and the strike fifty; "farther westward," he observes, "the "want of conformity is still more manifest," the variation in strike amounting to seventy degrees, and lower down the valley of the Lune other instances still more remarkable are adverted to. Mr. Sharpe concludes, "There is abundant evidence of both the old red "sandstone and Ludlow rocks having been dislocated before the "accumulation of the mountain limestone, as the limestone of Ken- "dale Fell rests in a nearly horizontal position upon the up-raised "edges of an anticlinal ridge of Ludlow rock, from which a cover- "ing of old red sandstone has been partially denudated."‖ Now, if a break or interruption in the succession actually exists between them, as is indicated by such hard junction in the west of England, and unconformity in the north, the interval implied might of course be sufficiently capacious for the reception of all the Devonian and Cornish rocks, and others which may be elsewhere still above them.

* "Geological Proceedings," No. 90, p. 760. † Ibid, p. 757. ‡ "Transactions of the Sections," p. 61. ‖ "Geological Proceedings," No. 85, pp. 605, 607.

These red sandstones (No. 2) are succeeded in an ascending and critically consecutive order by eight other great series of deposits, which severally vary in their mineral types and organic contents, the last or uppermost of which is the Cornish killas. That this great group overlies the floriferous or plant-bearing series, as I have termed them, or the "carbonaceous rocks," as they have been designated by Sir H. De la Beche and Professor Phillips, is as capable of demonstration as any geological fact of superposition on record. The diagrams which I now exhibit I have carefully copied from natural sections (almost as simple as those of tabular superposition), which show the killas to rest, as if tranquilly piled, on the plant or carbonaceous beds at Boscastle, Petherwin, Tavistock, &c. &c., and these are confirmed by the same continuous carbonaceous rocks in their most prominent and characteristic mineral and organic types, closely investing nearly the whole of Dartmoor, and underlying the entire killas country on the east, south, and west of it.

These facts confirm more strongly, if possible, the opinion I have long since expressed,* and I cannot but think they should either be disproved, or their legitimate consequences admitted.

The killas group naturally resolves itself into four subdivisions, which are severally characterized by appropriate mineral types and varying percentages of organic genera and species: these different members are inseparably linked together on their confines, by a common alternation of beds, and by insensible mineral gradations, and in the great natural scale are arranged in the following descending order:—

No. 4. The Ichthypherous, or Fish-bearing killas.

No. 3. The Metalliferous killas.

No. 2. The Padstow, or Tamar killas.

No. 1. The Tintagel, or Clymenien killas.

There is nothing arbitrary or inconstant in this fourfold division of the killas group, though from the several granitic interferences, and other derangements, they oftentimes deviate considerably in their

* See "Plausible Reasons and Positive Proofs; showing that no portion of the Devonian system can be of the age of the old red sandstone." By the Author. "London and Edin. Phil. Mag." Feb., 1842.

strike, and present a greater or less amount of surface according to the angle of inclination which their beds exhibit, or according as they may be repeated or not by flexures, and the varying bulk of matter which enters into their composition at different localities. With these limitations, and the circumstance that Nos. 1 and 4 are vast spheroid masses, the former thinning away to nothing up the Fowey estuary, near Lostwithiel, and the latter not being continued to either the south or the east of Dartmoor, every traverse made at right angles to the direction of their strike or bearing gives the same succession of the same peculiar mineral deposits, and the same sections throughout the entire killas region, from Torbay on the east to the Bristol Channel on the west.

No. 4, though containing interpolations of red and grey grits and impure calcareous beds, is usually abundantly variegated as a whole, its strata being red, green, greenish-grey, purple, and mottled purple and green, commonly glossy and unctuous, and of a more exquisitely delicate texture and foliated structure than any I have ever met with. It is characterized by the abundant remains of fish, which were first discovered by the Messrs. Couch, of Polperro, as has been fairly admitted, and some of which have been exhibited to the Society by Mr. Peach. They pre-eminently characterize this upper department of the killas, sometimes to such an amount that I entertain no doubt that a fish-bone bed as replete with their remains as that at Watchet, and Aust cliff in the Lias of the Severn, will hereafter be discovered; I have myself, in fact, found a fragment of such Ichthyolite bed in a portion of cliff which had fallen down on the shore, but have not yet detected it *in situ;* it is a consolidated congeries of fish remains. Of the great number of specimens I have collected, or which have been kindly shown me by Mr. Peach and Mr. Couch, with the exception of some defensive fins and fin rays which might or might not be "Onchus," they all appear to me to differ even in genera from any which have hitherto been figured from the Ludlow rocks or the old red sandstone.

This member of the killas series is of considerable thickness to the eastward, but gradually decreases in dimensions as it advances to the westward; on the eastern coast it extends from Man Sands,

near Brixham, by Noss Point on the Dart, and East Allington and Aveton Gifford, to the Start and Prawle Points, and the Bolt Head and Tail; where, though oftentimes in such conditions as refer to partial reduction by active heat, and even to semifusion, it may be followed and identified. Along its northern line from Man Sands to near the mouths of the Erme and Yealm rivers, in Bigbury Bay, it contains repeated interpolations of the red and grey grits and red slates of the next subordinate killas series (No. 3), and everywhere rests conformably upon it, with an almost permanent southern dip as far as the parallel of Stokenham and Kingsbridge, along which its beds are thrown back into a fan-shaped arrangement and a high northern dip. From Slapton Sands therefore on the east, to Thurlestone, in Bigbury Bay, on the west, they present a synclinal axis; from thence round Bigbury Bay to Yealm mouth, and thence in a line drawn to Cawsand on the west of Plymouth Sound, it overlies No. 3 killas with a high southern dip; round Whitsand Bay it constitutes the far greater portion of the cliffs in a narrow belt, sometimes thinning out in its deeper recesses, and unmasking the metalliferous killas, which is seen incontrovertibly to pass into and underlie it: this is notably the case in the deeper inlet of Looe Bay, where, from Millendreth to near Hannafore Point, there is not a vestige of it; Looe Island, however, consists entirely of it, where its beds on the north side dip S. 40°, and thence increase their inclination to vertical, and apparently 80° to 85° N. on the south end, in a fine fan-shaped form.

The eastern cliffs, from West Looe to Hannafore Point, where the fish-bearing killas again set on, afford fine unbroken sections north and south, showing the gradual transition of No. 3 into No. 4, and the indisputable underlie of the former. From Hannafore Point to near Hendrasick, No. 4 dips steadily and uniformly to the south and S.S.E., at high but varying angles: at Hendrasick cove, a great up-cast fault has brought No. 3 killas into hard collision with the middle beds of No. 4, which, after a variety of strange contortions, plunge headlong downwards after the junction line; but southward of this, on to Oarstone, and westward, to Talland, Polperro, Lantioc Bay, and the Fowey Ferry at Bodinick, they settle down to a high north and north-eastern dip. From Lantioc

Bay their southern line or terms, quitting the coast, strike off by Lanteglos and the Fowey ferry to "ancient inscribed stone" on the Ordnance map, on the north-west of Fowey, where they curve round and follow nearly the north and south line of road to Lostwithiel for two miles and a half, from whence they trend off obliquely to the north-east to Latine, on the west bank of the river, opposite St. Winnow, where, meeting with their northern line, they taper out to nothing; from Lantioc Bay, after their south, and round their west line just described, they are manifestly included in a trough of the subordinate fossiliferous killas (No. 3), which supports them everywhere along its northern and north-eastern confines, and is distinctly seen to emerge from below them at Lantioc Bay; at a little south of Bodinick, and north of Fowey; and all round their curved line up to Lantine. From Pencarrow Point and the Greber Head, round by Par Sands and St. Blazey, to the granite at Lanlivery, a powerful abnormal force has wrenched the beds out of their mean direction into a huge elbow with a flexured outline, from the inner angle of which No. 4 killas is deflected with them into a nearly north and south strike after the Fowey river and its eastward and westward banks.

With the exception of fish, other organic remains appear to be very rare. Mr. Couch, jun., however, has discovered several specimens of a small or young *bellerophon* at Polperro; and I have collected *spirifers*, &c., up the Dart, and *corals* and *crinoidea* in it at Whitsand Bay, and Beeson and Hall Sands, near the Start.

An abandoned mine near Lansallos, apparently one of the many monuments in Cornwall of the speculative epidemic of 1835, is the only instance I remember of any workings for metals, either ancient or modern, throughout its entire range. It affords good bluish-grey roofing-slates near Dartmouth, and would yield them also at other localities, probably, if sought for; but I know of no other quarries.

I have gone into details in regard to this series more precisely and particularly than I propose to give of the others, because its true position, and its relations to them, have hitherto been altogether mistaken: that it does not underlie the great killas mass, or in any way constitute "a south Devon axis," must be obvious from these

structural details, and the fact that it is of posterior formation to the floriferous and carbonaceous rocks. The distance in miles, in fact, along which it gives steady southward dips compared to that at which its beds are reversed and present northern dips, to say nothing of the permanent underlie of the abundantly fossiliferous and metalliferous killas (No. 3), the next in descending order, is thirty-four of the former and eighteen of the latter.

No. 3, or the metalliferous killas, is in almost diametrical mineral and organic contrast to the former series; so much so that anything like glossy, delicate, and crystalline slate, and fish remains, are as rare exceptions in it as metalliferous lodes and red and grey sandstones, and coarse arenaceous schists with innumerable organic remains of many genera and species, are in the other. The abundant evidences of its underlying the fish-bearing killas (No. 4) have been referred to in the description of that series.

No. 3 may be described as a vast detrital deposit of red and grey grits, containing throughout greater or less admixtures of volcanic ash or mud, in the form of blue or grey schists, red slates, &c. From this circumstance, and the enormity of its mass, it constitutes a broad and well-defined line of demarcation, and an invaluable middle term in a classification or analysis of the Cornish killas. At present I can only express myself generally, by observing that whether coarse or arenaceous schist obtains in some localities, or red and grey grits, either passing into quartz rocks or thickly intersected by quartz veins, predominate in others, a sufficient proportion of the lesser ingredients is uniformly present, or close at hand, to determine their inseparable relations.

It contains nearly all the lodes of tin and copper (including those of the granites which have been generated by its reduction in the volcanic furnaces) of any value in the killas group, except the inferior mines about Tavistock,* and on either side of Hingston Down, between Tavistock and Callington. One of its lodes, at Carn Brea, has probably yielded as much ore as all those Tavistock and Callington mines together.

* The rich and admirably-conducted mine Wheal Friendship is in the floriferous or carbonaceous series below the killas.

All the coral limestones of Torbay, from Babbicombe to Berry Head, are included in its upper terms there, which is sufficiently shown by its lower arenaceous schists and grits, such as overlie the Plymouth limestones of Mount Batten and Plymstock, being protruded through the Torquay* and Brixham limestones; viz., at Meadfoot Sands in the former case, and Mudstone Sands in the latter; and by those limestones containing thick interpolations of the same red slates (*e.g.* Daddy-hole Cove, near Torquay, &c. &c.) which pass from No. 3 killas into No. 4 above, and by the limestones at Sharkham Point, south of Brixham, with their upper red grits and schists, being closely associated with, and immediately underlying, the delicate upper killas (No. 4) at Man Sands.

The Dart sections describe precisely the same history of events, but in simpler and more explicit terms. From near Totnes to Sandridge Point, a nearly four-mile succession of red and grey sandstones, red slates, and calcareo-arenaceous grey schists (the whole at intervals showing efforts of the tiny coral creatures to establish their settlements), clearly underlie the limestones of Watton and Galmpton; and these in their turn, along the south shore of the Galmpton Creek to Greenaway House and Quay Ferry, as clearly underlie the upper red and grey grits and coarse schists, which continue for almost a mile to near Noss Point, and there support the upper killas (No. 4), which from thence to the mouth of the Dart, and the little bay west of it on the south of Stoke Fleming, overlie them with a permanent high southern dip.

The sections afforded by the Torbay coast on one side, and by the Dart and the intermediate country on the other, also clearly show that the Torquay and Yalberton limestones (part of the outer zone of a great curve) are conveyed to Churston Ferrers and Brixham by flexure and undulation. These limestones become of very attenuated dimensions at Ditsham, Cornworthy, and Harberton Ford, west of the Dart, and are represented farther westward by a broad calcareous, and often abundantly fossiliferous, band of grits and arenaceous schist, apparent at Staddon Point, and north of it in Plymouth

* This remarkable fracture was first noticed, many years since, by Sir Henry De la Beche. See "Geological Transactions."

Sound, at Hessenford, at East and West Looe, Fowey, Gorran, Carhayes, Veryan, and Gerrans Bay, and probably at Watergate Bay on the north coast.

This member of the killas group, considerable as it is there, is of insignificant dimensions on the east, compared to its vast development on the west, where it is evidently augmented by the introduction of new terms, derived apparently from local volcanic vomitories, the mud, ash, and elvan dykes, whose contents even now, in numerous instances, show striking affinities with the adjacent schists. The relative scarcity of ash, mud, and porphyry dykes on the east, is attended by a corresponding absence of much of the great schistose masses on the west, and by a greater preponderance of red and grey grits; whereas the gradually-increasing frequency westward of the ash, schist, and porphyry dykes, such as are seen from Redding Point (west of Plymouth Sound) to Cawsand, and abundantly elsewhere, is accompanied by augmenting interpolations of schistose matter (commonly however of an arenaceous character), and by less frequent beds of sandstone, although the red and grey grits of St. Agnes Beacon, or the eastward cliffs of the Helford creek under Mawnan, would suffer little in comparison with their cognate and congenerous deposits at Cockington and Windmill Hill, near Torquay. Nos. 3 and 4 killas, in fact, at either extremity, may be said to be adjusted together like a solid parallelogram cut into two wedges, the thin edge of the one being fitted against the broad head of the other.

This series to the eastward forms a portion of the outer zone of a great triple series of parallel concentric curves, the inner one of which, composed entirely of the floral or carbonaceous rocks, conforms perfectly to the south-east outline of the granite of Dartmoor, and in consequence (taking about its middle terms) it ranges from Cockington, near Torquay, by Cornworthy on the Dart, to Morleigh, Black-Down, the south of Modbury, Holbeton and Staddon and Redding Points, on either side of Plymouth Sound; west of the latter, and near the huge dyke of porphyry at Cawsand, a succession of dips from S. to S.S.W., S.W., and finally W., mark the angle from which its strike deviates to St. Anthony, Sheviock, Hessenford, Bin-Down, St. Keyne, and from thence follow the lofty

ridges of heather-brown hills by Pinnock Common, Five-Barrow Hill, Bodmin Downs, St. Breocks and Denzel Downs, to Watergate Bay: from this nearly central line, its beds on the west roll out to the southward in endless repetitions, by long undulations or rapid flexures as far as the granite of St. Ives on the north channel, and over the whole peninsula to the sea on the south, from Pencarrow point east of Fowey, to Falmouth, the Lizard serpentine and hornblende rocks, and the granite of Penzance.

Mr. Peach informs me, that with the liberal loan of books by the President, Sir Charles Lemon, he has been able to identify the following orthides which he has discovered in the vicinity of Gorran; viz., *Orthis lata, orbicularis, alternata, canalis, flabellulum, testudinaria, interlineata, sordida, plicata.* Five of the above species have also been found in the lower beds of the palæozoic rocks of Wales, one from the higher beds, and the remaining three, according to the lists of Professor Phillips and Mr. Sowerby, appear as yet to be peculiar to Devon and Cornwall: I feel assured that my collection will add some new and remarkable species to the above when described (as I hope they shortly will be) by that excellent naturalist Mr. James Sowerby.

The remains of fish, which occur so plentifully in the upper series, are apparently as rare in this as fossil molluscs, &c. are in the other. Sir H. De la Beche has however found a specimen at St. Columb Porth, and Mr. Phillips another at Meadfoot Sands, near Torquay, both in this formation.*

No. 2 killas is distinguished from the former by being an entirely independent series throughout, except on its upper and lower confines, along which it passes by alternation and mineral gradation into Nos. 3 and 1. Its mean bounding line from No. 3 is just above the range of the Plymouth limestones, or their equivalent grey, calcareous, and fossiliferous slates which supply their intervals of continuity; these are immediately succeeded below by an enormously thick suite of slates, strongly characterized as green, blue,

* See Phillips's "Palæozoic Fossils of Cornwall, Devon," &c. I have found portions of fish bones as low down as the Linton slates, and coprolitic-looking bodies in the trilobite slates near Barnstaple; and Mr. Parker, jun., late of Exeter, found a beautiful tooth in the Posidonia limestones of the Coddon Hill grist series at Doddiscomb Leigh, north of Chudleigh, which Prof. Owen pronounced to belong to a genus of fishes hitherto found only in the Urals.

purple, and grey (the purple chiefly prevailing), in almost endless alternation, down to the upper beds of No. 1. Abundant facilities of identifying and observing their striking peculiarities, as contrasted with all or either of the others, are afforded, more especially by the cliffs on either side the Tamar, from Plymouth up to near Pentilly Castle on the eastward region, and the shores of the Padstow estuary on the west, from Wadebridge to Stepper and Pentire points at its mouth. The sections and succession of the same mineral beds, with the same fossils in the upper ones, and the same apparent absence of them in the lower, are so complete along the Padstow shores, that, regarding the same variegated beds underlying the same grey calcareous slates, and these in their turn in like manner underlying the arenaceous and coarse schistose deposits of No. 3 on the south; all the facts and circumstances were too strikingly associated in the same order to permit me to entertain much doubt of their identity, even at an early period of my survey, before I had proved their continuity throughout the intermediate region, and collected along the north shore of the Padstow river a greater abundance of the same *trilobites*, *molluscs*, *corals*, and *crinoidea*, than I had gathered among the same grey calcareous slates in the same relative position near Plymouth.

Another marked and peculiar feature of this series, compared to Nos. 3 and 4, is the total absence of the red and grey detrital aggregates, or their coarse arenaceous admixture, such as obtained throughout No. 3; while among all its vast terms below the level of the Plymouth limestones and their representative grey calcareous slates, east and west, I have hitherto been as unsuccessful as Prof. Phillips and Mr. Wm. Saunders in discovering any organic remains.

The limestones of Rock Ferry, opposite Padstow; of Butterville and Millaton, near St. Germans; of Plymouth, Yealmpton, Ugborough, Dartington, Berry-Pomeroy, Marldon, Broadhempston, Ipplepen, Denbury, Abbot's and King's Kerswell, Newton Bushel, and the east and west Agwells, belong to the upper terms of this series. Judging from their position and apparent underlie, and the intimate association and intermixture of the purple and variegated slates, the Ipplepen, Denbury, Agwells, and Newton Bushel limestones occupy a somewhat lower level than those of

Little Hempston, Bunker's-hill (near Totnes), Berry-Pomeroy, and Abbot's and King's Kerswell, the latter being parted by, and associated with, the upper grey calcareous and fossiliferous slates which so commonly constitute the true equivalents of the Plymouth limestones in their absence. My arrangement, in fact, of the South Devon limestones has been governed entirely by the order and succession of the killas and carbonaceous series which there severally envelope them, and there is no other rule, with security from error, which can be relied upon. The slates and grits are constants; the limestones, accidents. In this view the lime-rocks of Buckfastleigh, Ashburton, Bickington, Chudleigh, Ideford, and Lyndridge, belong to the floriferous or carbonaceous series, at about the same level as the Bampton, Holcomb, Rogus, and Westleigh limestones on the north, all of them perhaps not much below the horizontal parallel of the Petherwin. Some of the Chudleigh fossils, so far as their evidence is of any value, are apparently identical with some of the Petherwin.

It appears throughout to be as poor in metals as No. 4, as I do not remember any lode of any promise or importance being worked in it; it however affords roofing-slates, which I believe would equal in quality any in England, if quarried to a sufficient depth, and with the requisite skill and capital.

Its northern line or boundary ranges from Staple-hill, on the south-west of Bovey-heath, near Chudleigh, by the north of Ingsdon, to a little south of Bickington and Ashburton; a little east of Buckfastleigh; the south of Dean Church; South Brent, and Ivybridge, to Beechwood and Shaughwood, up to which point it is in hard junction with the carbonaceous rocks; from thence it takes a westward strike (accompanied by the Tintagel killas (No. 1) which there first sets on) to Tamerton Foliot; the north of Landulph; Pillaton, and the north of Quethiock, to the south foot of Caradon Down; from hence the entire series is represented chiefly by a narrow band of the upper beds which flank the granite, by St. Neots to Cardinham, on the west of which it again expands; and its northern line ranges after the west escarpment of the granite to Blisland and the west of St. Breward, where, meeting again with the lower killas series, No. 1 (which had described a great semicircle from St. Ive

round the same Bodmin Moor granite by its eastern, northern, and north-western frontiers), they range together in a nearly east and west direction by a little north of Endellion, to the sea, between Portquin and Porteath: strange as these remarkable lines may appear to some, I am convinced they will be obvious to any one who will follow them out as I have done.

Its southern terms are clearly deflected to the north-west, on the west side of the Tamar, conformably to the deviation in strike of No. 3, at Cawsand, as before adverted to; advancing in this direction towards Menheniot and Quethiock, the beds are seen to be no longer affected by the high angle of dip which had displayed the entire series in such minute detail and fine succession on the Tamar (as it also does from Endellion to Constantine Bay on the west of Padstow); but they have settled down to so low an inclination as has permitted the metalliferous series (No. 3) to be expanded over a great portion of the intermediate area, from a mile or two north-west of St. Germans to nearly three miles north of Liskeard.

A similar phenomenon may be observed on the north-west of Bodmin, over a considerable area, where the upper grey calcareous beds of No 2, being sometimes apparently flat, or at others inclining at a very low dip, conceal all the subordinate variegated beds, until between St. Mabyn and St. Tudy a higher angle brings up the blue, purple, green, and grey slates, which range continuously from thence by Endellion, St. Minver, and St. Enodock, in a thick zone, to the north and west of Padstow.

No. 1, the Tintagel or Clymenien killas, is of perfectly unique mineral type, and a certain proportion of its fossils are as yet equally appropriate and characteristic: it is almost uniformly a delicate pale green, or greenish-grey slate, rarely a bluish-grey, with quartz veins, commonly crystalline—sometimes highly so: it is more or less calcareous throughout; but its nether division, from Tavistock on the east, to Trevalga and Tintagel on the west, contains masses of varying dimensions—oftentimes continuous for many miles together—of a highly calcareous hornblendic and chloritic volcanic ash, which, on decomposing, always constitutes a fertile soil; and at Bradstone, Kelly, Milton Abbot, Lamerton, and on

the north of Tavistock, affords some of the richest land in England.

That it forms the basis and supports the great killas superstructure, is abundantly shown by explicit sections on either side the Tamar—at inland quarries and cuttings, and on the westward coast on the south of Port Isaac, where it passes insensibly into No. 2 by neutral and alternating beds, and indisputably underlies it.

It yields tin and copper near Tavistock and Callington, and lead and silver are worked in it to a greater extent than in either of the killas series above it; excellent roofing-slates are also quarried in it at Tintagel and Delabole on the west, and at Mill-hill, near Tavistock, on the east, and they have also been proved at several intermediate points.

It passes into great lentiform bunches of lime-rock at Trenalt and Petherwin, near Launceston, which rests on, and are parted by, black anthracitic slates, with thin layers of culm, identical with such as are seen in the subjacent carbonaceous rocks: these limestones to the eastward gradually thin out to nothing, by irregular seams and flat insulated cakes, among true killas slates; but their earliest introduction is manifestly by thin calcareous courses containing the characteristic Petherwin fossils, among the underlying carbonaceous rocks, as may be seen south of Landue Mill, near Launceston: these limestones and associated slates are at times as abundantly loaded with the remains of ancient life as any of the secondary rocks. I have seen, in short, masses of lime-rock which decomposition showed to be concretionary aggregates of organic structure: of these I have been fortunate enough to obtain a very large and varied assortment, many of them as yet undescribed; among other large specimens of the beautiful *clymenia*, I have one which is nine inches in diameter.

This lowest member of the killas group does not appear at all on either the east or the south of Dartmoor, and is first met with on the south-west of it, a little north of Borringdon Wood, from which its southern line is of course the north one of No. 2, already described, as far as a little south of St. Ive, from whence it mantles round the inner zone of carbonaceous rocks (which closely invest the Bodmin Moor granite on the north and north-west as far as near Michaelstow, on the S.S.W. of Camelford), beyond which, falling

in again with No. 2 in accompanies it to the sea in the south of Port Isaac, as before observed, and does not appear afterwards in any of the southern sections, a circumstance which, coupled with the interposition of No. 2 along the Padstow estuary and to the eastward of it, proves that the fossiliferous beds of Pethervin are not conveyed to St. Columb-Porth, New quay, &c. as has commonly been supposed.

The accumulated evidences of the superposition with regard to the plant or carbonaceous rocks are so strong, that any attentive observer must admit that this series overlies and passes downwards into them, by far more abundant and conclusive instances of simple section, gradation, and alternation, than even those carbonaceous rocks present on the north of Devon, where they are now admitted on all hands to pass by insensible transition into the older group of Exmoor: the evidences of the former are certainly far more abundant and demonstrable than anything of the kind I have ever met with elsewhere, but exhibited at times on so vast a scale, that the fidelity of their details is apt to be overlooked in the magnitude of their proportions: in the instance, for example, on the west bank of the Tamar, a traverse of six miles of country; viz., from about two miles east of Pethervin to South Hill near Callington, displays nothing but natural beds or interchanges, or interlockings, of killas and carbonaceous rocks, or of carbonaceous rocks, traversing and piercing through the killas, prior to the latter overwhelming them by its enormous accumulations.

The Boscastle sections however, on the other hand, are so readily comprehensible and simple, as scarcely to admit a doubt of it, corroborated as they are by the coast cliffs to Tintagel, where the anthracitic schists, which are seen in mass at Boscastle supporting the killas in almost a tubular form, are observed to be continued upwards among the pale green roofing-slates by repeated interpolations, of which ready examples may be seen close by the church at Trevalga, a little farther south, at Treworthal.

Such are the natural subdivisions of the great killas group, founded on peculiarly-appropriate types and continuity of series, guided by, which I trust I have sufficiently shown that I have relied on, or misled by, nothing which was arbitrary or inconstant.

Its position as the crowning extremity of a magnificent, consecutive, and abundantly-varied series (as yet unrivalled by any hitherto developed by rigid and direct analysis), I have endeavoured to show as clearly and in as much detail as the nature of the communication admits, and so far its place in the European system may be determined and mapped down with certainty, if it shall eventually be shown, as I confidently anticipate it will be, that I have been correct in my views, that the entire Devonian and Cornish group is based on (probably the upper beds of) the old red sandstone.

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ROYAL

Geological Society of Cornwall.

THIRTY-FOURTH

ANNUAL REPORT

OF THE COUNCIL,

WITH THE

PRESIDENT'S ADDRESS,

AND

PAPERS AND NOTICES

READ TO THE SOCIETY.

PENZANCE:

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PRESIDENT'S ADDRESS.

SINCE we last met, the Geological Society has lost two of its members,—men, distinguished for their knowledge and ability, and who were friendly to the science which we cultivate.

Mr. Paynter, of Boskenna, joined the society at its first commencement, and continued throughout its course to give it his countenance and support. It is not right in this place to intrude on private grief by any allusion to the personal qualities which endeared him to his friends; but, as a member of the Geological Society, his loss to us is deeply to be regretted; for he generally attended our meetings, took part in the business of the society, aided us by his advice, and contributed largely to our museum.

Mr. Woolcombe, President of the Literary and Scientific Society of Plymouth, was less closely connected with us, but he felt the value of our Institution, and saw that it was rightly placed for the promotion of science. Distance, therefore, abated nothing of his interest in our proceedings, and we have reason to deplore his loss as of a sincere friend to us and our pursuits.

Within a few days, the society has suffered a further loss in the lamented death of Mr. G. D. John. Surrounded as I am by his personal friends, in the place of his constant residence, it would be giving needless pain to touch a wound so recent. But I am bound to notice the fact, and I will enlarge on it no further than to say that he was one of our original members, and that he served on the council more than once.

The additions to our numbers are only in prospect. No person has yet been elected under the new regulation, which constituted a second class of members, paying only five shillings per annum, but becoming, thereby, entitled to receive our publications gratis,

to visit the library and collections, and to share in all the privileges of the other class of members, except that of taking part in the government of the society. Three persons are now candidates for admission on these terms, and it will be a part of our business to-day to elect them. That there should not be more persons willing to take advantage of this by-law, is, I think, in some measure owing to its having been very imperfectly made known that such a by-law exists. In fact, it has been published in no other way than by an allusion in the President's address of last year; the report of the council, having by an accidental omission, made no mention of it; so that it is not at all improbable that the allusion in the President's address may have been taken as a mere suggestion, not yet sanctioned by any act of the council or society. The council have now repaired this omission; and I feel sure that the interest which the proceedings of the society are calculated to excite in those men of moderate means who take pleasure in considering the structure of the earth, or who have their occupation amongst its strata, will henceforth be greatly extended. Their sympathy will be profitable to us in many ways. Let us take as an example the Institution lately opened at St. Just. A more laudable endeavour on the part of those engaged in this noble undertaking, to concentrate their scattered knowledge and diffuse it amongst their community, it is hardly possible to conceive; and I feel sure that I have not stepped beyond the licence allowed me as your President, in assuring them of your hearty good will towards their Institution, and your desire to co-operate with them. To men so bent on knowledge, the regular receipt of your publications must be important; and yet the larger sum hitherto paid by the members of our society might possibly be inconvenient. But the small sum of five shillings will not be felt; and I am sanguine enough to think that the honour of belonging to us will not be altogether disregarded.

Connected with this subject, I beg to bring to your minds the efforts which we have at various times made to obtain for the society the direct co-operation of the miners, but hitherto unsuccessfully; for even the premiums which we have offered, with a view to induce them to communicate with us, have been without result. I have been told that this backwardness proceeds from the reluctance of

the miners to put pen to paper. They are, as we all know, most acute observers, and very ready to impart the result of their observations; but not being in the habit of writing for publication, they are unwilling to write; and, therefore, if we desire to possess their thoughts, we must employ some other hands than their own to record them. I have thought it worth while to make the experiment of employing the secretary of the Polytechnic Society in this service; and he has very kindly lent me his assistance. The result will be laid before you in his own words, and I have only to notice the very trifling cost incurred,—his actual expenses having been only 12*s.* 6*d.*; but, of course, I have made some addition to that sum in the way of remuneration for the time and labour which he has expended. Being an experiment of my own, made with a view of bringing before the society in a practical and intelligible form the plan which I propose that we should adopt, I have made this trifling expense a matter of account between Mr. Rundell and myself; but if it should please you to continue the experiment for another year, it will be necessary for you to place at the disposal of the council a small sum to be expended at their discretion, and to call upon them to make a report on its application at our next meeting. A resolution to this effect will be proposed to you.

Every one here present, no doubt, is aware of the progress which has been made by Mr. Hunt, and before him by Mr. R. W. Fox, in imitating the processes of Nature by which rocks are consolidated, lamination formed, and certain veins distributed through the earth. The agent with which they worked was a feeble and long continued current of electricity, such as we have every reason to believe is always present in all parts of the earth's substance. Mr. Couch has lately employed the same agent to imitate experimentally another of the secret processes of Nature, by which she substitutes one material for another, in a mould which is still preserved. Thus is produced fossilization and pseudo morphism. Undoubtedly it would have been more agreeable to the society that Mr. Couch should himself have given some account of his experiments; but he is unwilling to make a formal announcement of results which are uncertain; and some months must yet elapse before the slow processes by which he works can be brought to a more perfect con-

clusion. At the same time, I am sure that it will interest the society to know that an inquiry of this kind is in hand; and therefore, with his permission, and almost in his own words, I venture to lay before you the following statement. It appears that Mr. Couch conceived the idea that if slow action could be established with reference to the objects to be operated upon; that is, if the currents by which the changes of substance are to be effected, could be produced by the substances themselves, the imitation of the natural process would be more close, and the success greater. He, therefore, took a recent shell, which had been partially decomposed by exposure on the beach, and placed it under an exhausted receiver in a solution of silicate of potash; and by means of a single pair of plates, under a low excitement, he passed a current of galvanism through the shell, still being in the fluid, the whole being enclosed in clay. At the end of five months he found that the shell had undergone great changes, that the silica had been deposited in the cavities in a crystalline form, and that in some circumscribed patches the lime had entirely disappeared, and silicious deposit had been substituted. In other places, where the action was more intense, the shell sometimes became coated with silex; and again in others the calcareous matter crumbled into powder, leaving small cavities. In a few cases the whole shell disappeared by disintegration. Mr. Couch has repeated his experiments, but with various results; so that the conditions necessary to secure complete success have not yet been fully ascertained. It is worthy of remark, however, that in some of the small patches of artificial fossilization, crystals of silex were formed, not assuming their own proper form, but exhibiting the structure of the shell thus metamorphosed. The shells operated upon by Mr. Couch were *Mactra stultorum*, *Donax truncatulus*, *Ianthina communis*, and *Natica glancina*, the last of which assumed every appearance of a fossil from the chalk.

The trustees of the British Museum have lately given orders that casts should be made of some of the fossils in their collections. The plan has proceeded only a little way at present; and I believe that not more than four or five casts have yet been made, two of which I beg to present to the society. That of the *Holoptychius nobilissimus* it appeared to me to be of great importance that we

should possess. It is taken from the most perfect specimen yet discovered of that fish, which is so characteristic of the Devonian formation. Many fragments of its scales have been found in Cornwall, and they have been of the greatest use in determining the age and character of our rocks. Thus much on the scientific value of this fossil; but I look forward to its affording some amusement also to those, who, without reference to the strata in which they are found, take an interest in the records of the various forms of life which have inhabited this earth at different periods of its existence. We have in our library an easy and very simple description of this, and of several other kinds of fish found in the Devonian rocks, whose history began, and sometimes ended, in that very remote period of the earth's age. I allude to Millar's "Old Red Sandstone," a book adapted to every class of readers. It may, perhaps, interest those who are not accustomed to study such records of ancient times to be told that above 1,500 species of fossil fish have been determined by Agassiz; the whole number of living species being about 8,000. I take this fact from Mantell's "Medals of the Creation," a cheap little book which I venture to recommend to any one who wishes to have an idea of the vast amount of life which once animated our rocks, the corporeal remains of which now form a considerable portion of their substance. The other cast is of the *Homalonotus delphinocephalus*, a fossil very characteristic of the Ludlow rock in the upper Silurian system, but, I believe, not found in the lower. As the discoveries of Mr. Peach have now placed it out of doubt that we have both upper and lower Silurian remains in our strata, it struck me that it would be convenient to place this specimen on our shelves, to which reference may be had, without loss of time, by any one who may find a fragment at all resembling it. So crushed and obscured as all our fossils are, by the violent changes to which they have been subjected, it is only by fragments that we can ascertain their existence; and the possession of a tolerably perfect type or model, though it is only of a single species, may possibly be of some use.

I cannot turn away from this subject, without a passing remark on the very valuable addition which Sir Roderick Murchison has made to the knowledge of our own county. His visit was short,

and commenced without any view, except to friendship and amusement. But it is the character of genius to make leisure productive, however it may occur; and he has opened to us a field which I hope that we shall abundantly cultivate.

That we are making progress in science I think no man can doubt; and, though we are beholden to external aid for much which has been learnt of our geology, still it would be unjust to the constituent members of our own body, to deny that our internal resources are also great; and that the zealous and industrious application of these resources has done much to spread abroad the credit and character of our society amongst our contemporaries and fellow labourers in England and on the Continent. To these men, the working bees of our hive, we owe the gratitude which is justly due to those who reflect honour on their native land.

THE THIRTY-FOURTH ANNUAL REPORT OF THE COUNCIL.

At our last annual meeting we completed our 6th volume of Transactions, and with the present year we commence a new one, which the council hope will contain the result of further investigations of the geology, and especially the palæontology, of Cornwall.

In our mineralogical pursuits, the council have but little or no progress to announce. Notwithstanding the repeated offers of premiums, made through this society to the mine agents and miners of Cornwall, for the purpose of inducing them to record the results of their observations on the mineral deposits daily inspected by them, we regret to observe that there have been no competitors.

In the hope of interesting our practical miners, it was proposed, at the last anniversary, that a second class of subscribers should be admitted into the society by an annual payment of five shillings; and that such members should be entitled to receive the reports, and should possess all the privileges of other subscribers, except only the power of being on the council, or of taking any part in the direction of the affairs of the society. By thus inducing the mine agents, and others connected with mines, to join us in our pursuits, we may hope to accomplish the end originally proposed by the offer of premiums. A few have already taken advantage of this offer, and it may be presumed that when the proposal is more generally known, many others will be glad to embrace it.

The council have great pleasure in observing that the investigation of the fossil geology of our own county still advances. This is a subject to which the council would once more especially direct the attention of the zealous working members of the society. A large portion of the last volume is dedicated to this branch of

science; and when it is remembered that the discovery of fossils in Cornish rocks is but of recent date, the council may venture to hope that the advance already made is only an earnest of what may be expected from future investigations.

Mr. Pattison, of Launceston, has followed up his observations on the carbonaceous deposits of the county, read at the last meeting, by further researches into the deposits of our northern shores, extending in a westerly direction from those previously described. This line of research is particularly desirable, since it is in the region of the junction of the carboniferous and Devonian rocks. His Paper on this subject is accompanied by illustrative fossils.

It will be in the recollection of this meeting, that a few years since, when a description of the submarine forests, extending almost the whole length of our southern shores, was brought before the society, an idea was thrown out, from the identity of the rocks on both sides of our county, that similar beds, containing trees of the same kind, would be detected flanking our northern rocks. From another communication from Mr. Pattison, it appears that during the past year similar remains of a submarine forest have been discovered near Bude, on the northern coast.

Our active member Mr. Peach still continues his researches; they have already thrown new light on the succession of our Cornish strata, and proved the existence of true Silurian, and even lower Silurian, rocks in Cornwall. His Synopsis of Cornish fossils which was published in the society's last volume, is sufficient to shew how far his labours had then extended, and his subsequent communications, especially his Paper now before the meeting, accompanied by a series of illustrative fossils, will shew the rapid progress he has since made. To enable him to continue his researches, the council have no doubt that the members will cheerfully second their suggestion that a further sum of £5 be placed at his disposal.

Among the minerals that have been placed in the museum during the year are some specimens of stilbite from Poonah, and of corundum, ruby, spinel, and other gems, from Ceylon. They were presented to the society by Mr. Bowman, an experienced traveller in the East, and an eager mineralogist; and the council

recommend that Mr. Bowman's name be added to your list of corresponding members.

The council cannot close their Report without again calling the attention of the society to the absolute necessity of more space for the museum. The fossiliferous collection increases so rapidly that it is quite impossible to arrange the specimens in their order of succession, or indeed to exhibit a considerable part of them at all. Even the simple minerals, although of far less importance, cannot be properly arranged. The council venture to hope that, often as they have pressed this subject on the attention of the society, it will at length command the attention it deserves.

By order,

L. R. WILLAN,
SAMUEL PIDWELL, } *Secretaries.*

Oct. 1st, 1847.

DONATIONS TO THE MUSEUM.

1. Crystallized iron, from the North United Mines, Zennor. By S. Higgs, Esq.
2. Suite of specimens from the serpentine district. By Mr. Verran.
3. Suite of fossils from the south-eastern parts of England. By — Rogers, Esq.
4. Specimens of fossil wood, from the rocks adjacent to Macquarie Plains, Hobart Town, Van Diemen's Land. By W. D. Land, Esq.
5. Organic remains, from the south-east part of Cornwall. By R. Q. Couch, Esq.
6. Organic remains, from Lanivet. By C. W. Peach, Esq.
7. Organic remains, from Tintagel and the neighbourhood. By S. R. Pattison, Esq.
8. Regulus of cobalt. By R. Pearce, Esq.
9. Specimens of silver ore, and galena. By P. Johnson, Esq.
10. Specimens of rubies, sapphires, garnets, amethysts, and other precious stones, from Ceylon, and stilbite, from Poonah. By J. Bowman, Esq.
11. Selenite, from the Falls of Niagara. By R. Watson, Esq.
12. A specimen of a well-defined vein of copper, from Ballymurtagh; red oxide of copper, as found in the soil near copper lodes, and massive black oxide of copper, from Coquimbo; fragment of a pebble of copper, from Lake Superior; and red oxide of copper, from South Wheal Basset. By. J. Garby, Esq.
13. Red hematite. By W. Carne, Esq.
14. Specimens illustrating Mr. Rundell's Report on certain appearances in Gwinear Consols and Wheal Seaton.
15. Specimens of oxide of iron. By J. Batten, Esq.
16. Cast of *Holoptychius nobilissimus*. By the President.
17. Specimens from quarries in Lincolnshire. By Rev. C. V. Le Grice.
18. Silver-lead ore and carbonate of lead, from Trehane Mine. By Mr. George Jennings.

DONATIONS TO THE LIBRARY.

1. Transactions of the American Philosophical Society at Philadelphia. Vol. 9. Part 3.—Proceedings of ditto. Nos. 34 and 35. By the society.

2. Address delivered at the anniversary meeting of the Geological Society of London in 1847. By the Author, L. Horner, Esq.

3. Remarks on Tides and the prevailing Currents of the Ocean and Atmosphere. By the Author, W. C. Redfield, Esq.

4. Report of the British Association. 1846. By the association.

5. Transactions of the Geological Society of London. Vol. 7. Part 3.—Quarterly Journal of ditto, for Nov., 1846, & Feb., May, and Aug., 1847. By the society.

6. Bulletin de la Société Géologique de France.—Viz., 2 numbers for 1843–4, 4 do. for 1844–5, 5 do. for 1845–6, and 1 do. for 1846–7. By the society.

7. The 14th Annual Report of the Royal Cornwall Polytechnic Society. By the society.

8. List of Members of, and Donations to, the Geological Society of France. By the society.

TREASURER'S ACCOUNT.

RECEIPTS.	£	s.	d.
To balance due to the society last Meeting.	151	16	3
Subscription from His Royal Highness the Prince of Wales	20	0	0
Ditto from His Royal Highness Prince Albert	10	10	0
Subscriptions from ordinary members, and arrears	110	5	0
For 3 copies of 5th vol. of Transactions.	3	15	0
	£296	6	3

DISBURSEMENTS.	£	s.	d.
By Rent (less received for the News Room)	24	10	0
Insurance	3	3	6
Housekeeper	5	5	0
Taxes	2	18	6
Repairs, &c.	3	2	8
Advertizing	4	17	3
Coal	4	4	6
Printing last Report	10	17	6
Periodicals and Stationery	4	19	6
Expenses last Anniversary	3	5	6
Subscription to Mr. Peach	5	0	0
Paid for Specimens, Books, Map, Postage of Reports, petty expenses by the Secretary, &c.	6	19	0
Balance in favor of the Society	217	3	4
	£296	6	3

On the Geology of the Tintagel District.

By S. R. PATTISON, Esq., F.G.S.,

MEMBER OF THE SOCIETY.

Under this title, I propose a brief continuation of my communication of last year, descriptive of the Coast line of North Cornwall.

The space intended to be described is bounded by Port Isaac on the south-west, Boscastle on the north-east, and the granite of the Roughtor range on the east: limited opportunity alone occasions my attempting so small a district.

The sequence of the coast strata southward from Boscastle appears to be:—1. A black contorted slate rock with occasional shining surfaces, containing minute crystals of pyrites and frequent veins of quartz. The contortions abound most near the quartz veins: the soil is stained with a black colour wherever these veins occur, and is of inferior quality. The rock is much broken, and does not contain any true slate, nor good building stone, nor any fossils except some traces of encrinite stems. 2. A series of fawn-coloured shales or sandy beds, rarely fossiliferous in any part, and scarcely at all in the uppermost layers. 3. Another set of black beds, similar to No. 1, and very variable in thickness. 4. A succession of hard slaty rocks, containing the true slate, and occasionally fossiliferous.

All the beds of this description recurring along the coast are probably of the same formation.

No. 1. *The dark rocks.*

The base of the carboniferous system consists of a coarse black slaty rock abounding in quartz;* this is largely developed at Tresparrett cliffs, and thence towards the south-west at Pentargin and Boscastle. From underneath this, at Grower, south of the

* Report, 1846, p. 70.

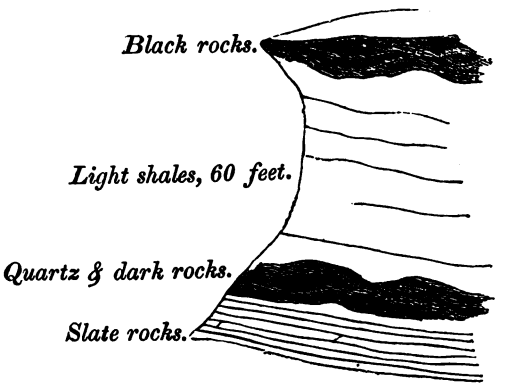
last place, rise the slate rocks of the Devonian system. No decided unconformity exists, and the difficulty of drawing a boundary line is increased by the recurrence of similar black rocks in thinner strata amongst the lower slates. The absence of fossils,—the general agreement in dip,—and the similarity of structure, render the accurate determination of the limits of the two systems here exceedingly difficult, if not impracticable.

The occurrence of the strata on a line running north from the granite of Brownwilly is as follows:—1, micaceous slates; 2, greenstone; 3, thin black bed; 4, slate bed, with *spirifera, encrinites,* &c., at Trevivian; 5, black bed; 6, slaty greenstone and calcareous ash; 7, coarse slates; 8, carboniferous grits; 9, coarse dark slaty rocks, all having a northerly dip. The spiriferous slates at Trevivian are of the same description and colour as the Tintagel slates: the dark rocks Nos. 3 and 5, which occur amidst the slates of the above-mentioned series, are very similar in appearance to the black slates No. 9, which form the base of the carboniferous system from Tresparrett to Boscastle: no fossils exist in either case to help the observer. The upper rocks are much more contorted than the lower, and the strata are sufficiently distinct in their mineral characters, both above and below; but the external appearance of these dark strata, whether associated with the lower slates, as at Tintagel and Port Isaac, or within the carboniferous line, as at Pentargin and Tresparrett, is remarkably similar. The conclusion which may be arrived at is, that there are similar mineral masses in this district in each system. One range of these rocks may be traced from beneath the gritty strata west of Halworthy, running by Touchbarrow, Waterpit down, and Trevalga, to the coast; another band appears at Lesnewth, and continues with a strike towards Boscastle, of which it forms the harbour: it then overlies the slates at Grower, and recurs at Bossiney.

No. 2. *The fawn-colour shales.*

Associated with the dark rocks before-mentioned and underlying them occurs a series of light-coloured sandy shales rarely abounding in quartz, not bent into such frequent or violent flexures as the darker rocks: some of the beds furnish a rough flag-stone used

for fences,— the only material applied to economical purposes. The black and white strata are irregular in their thickness, nor do they always occur in the same order, but their usual appearance may be judged from the accompanying sketch of a cliff west of Tintagel Church.



No. 3. *The lower dark rocks.*

These slaty rocks are variable in their texture and composition: they are less disturbed in their planes than the upper beds, and are more compact and crystalline in the mass. The good slate does not, I think, always occur at the same depth in this formation, but in irregular masses, as though dependent on some slight change of mineral constitution, or in the subsequent crystallizing forces. These slates are distinguished by a uniform thin cleavage, equal consistency, metallic ring, and pale green colour: they may also be characterised by the frequent fragments of fossil casts coated with a green shining substance, and also by the appearance of round or oval stains which are owing to decomposed organic matter: these organic traces are in some quarries so few and faint that, but for their greater abundance and clearness in others, we might consider the slates wholly non-fossiliferous.

No. 4. *The hard slaty rocks.*

This series consists of altered slaty rocks containing crystalline strata, forming the cap of the district towards the granite on the

east: these are associated with fine micaceous sandstone, worked for building and flag-stones. The general character of these strata is preserved from Boscastle to Port Isaac; between the latter place and Port Gavern the dip is south-west: at Port Gavern, on the northern side of the creek, claret-coloured slates first appear, separated by a mass of slaty greenstone from the black rocks which exist in great force here and at Port Isaac.

Associated Trap rock.

The igneous rock of this district is a greenstone, occurring in ranges nearly parallel to the strike of the beds, following the course of the river Inney to Davidstow, and thence by Touchbarrow curving round to Tintagel. The largest development occurs in the valley through which the river flows, where it is displayed in the picturesque rocks forming the northern bank. It is along this line also that the substance occurs which Sir Henry De la Beche has named *volcanic ash*.—"The passage of the ash "beds into slates is often most gradual, pointing to the termination "or commencement of a mingling of the mud with volcanic ash "of the time, at the sea bottom: some of the trappean rocks are "vesicular, the vesicles filled by carbonate of lime, which, when "the rock has been long exposed to atmospheric influences, is "removed, and the trap retains its original vesicular character:— "some of these vesicular rocks closely correspond with pumice, "when the carbonate of lime has been freed by natural or artificial "means."* The pumice-like fragments may be noticed at intervals from Lesnewth by Bossiney to Trevena.

Another variety in which trappean rocks occur is an argillaceous greenstone, or sedimentary deposits arising from the decomposition of this stone, and variable in its crystalline character. "There "is in fact so intimate a mixture of compact and schistose trappean "rocks with the argillaceous slates, that the whole may be regarded "as one system; the two kinds of trappean rocks having been "probably erupted, one in the state of igneous fusion, and the "other in that of ash, during the time that the mud now forming "slates was deposited."† This slaty greenstone is calcareous on a

* Memoirs of Geol. Survey, vol. i., p. 82. † Report on the Geology of Cornwall, p. 57.

line extending from St. Cleather, west of Davidstow church, to Grylls and Bossiney: it has been worked for lime at Tremblary in Davidstow within the last three years, and formerly at Grylls. The former place exhibits highly crystalline green calcareous rock, the lime forming a portion of the slaty greenstone, and existing in sufficient abundance for economical purposes, but the difficulty of separation from the greenstone is so great as to prevent its profitable working.

I noticed a few obscure but undoubted traces of *crinoideæ* in this calcareous rock at Davidstow, which are interesting as shewing the deposit to have been contemporaneous with the great slaty mass, and so gradual as not at once to extinguish the marine life which then existed.

The varieties of greenstone are,—1, a dark foliated hornblende rock, usually occurring near granite; 2, a large-grained greenstone; 3, an earthy greenstone with stains of iron; 4, a dark blue crystalline kind with quartz partings; 5, a blue recomposed rock, sometimes like a cinder, and at others like a conglomerate; 6, a vesicular stone, either amygdaloidal, or like pumice;—together with decomposing matter of all the varieties. There is a different kind of trap rock in the vicinity of Camelford, running parallel to the granite there, and known as the Camelford white elvan: it is a crystalline rock of felspar and quartz without any trace of colouring matter.

The trap of this district does not appear to have exerted any violent effects on the rocks in immediate contact with it: such results are not to be expected where it occurs to so great an extent as a contemporaneous slaty deposit. The junction of the granite with the greenstone is nowhere seen, as the latter mantles round the former.

The occurrence of most of our valuable deposits, whether of limestone, manganese, or slate, in connexion with ranges of greenstone, would suggest a probable connexion between the causes which produced both. The economical worth of all mineral deposits depends on the state of separation in which the several minerals are found, and this would appear to be dependent on the intensity of the forces instrumental in producing the phenomena.

A deposit of sand and mud holding diffused calcareous matter, too lightly charged to constitute limestone, might, by any force which would produce re-arrangement and crystallization, become beds of limestone, shale, and slate, or exhibit concretions of either.

The map and descriptions of the slate quarries of North Wales shew the close alliance there between productive slate and greenstone:* thus the most apparently desolating agencies have had their commission of utility.

Dip and Cleavage.

Dip.—I verified most of the dips noted in the Ordnance map, and obtained others in general accordance with them. A series of lines at right angles to these, will represent the strike of the beds, and discloses the curious fact that this district forms a dome of elevation, having the high ground at Condoldon or Cadon Barrow for its centre, and connected with the granite by an anticlinal line: one portion of the dome dips into the sea, another towards the south, a third towards the north, and the other is held up by a connecting line towards the granite at Roughtor.

The dip along a line from Halworthy to Boscastle is northerly; at Tintagel it is towards the sea; at Portgavern it is south-west. The strike of the beds accords with this, and thus a continuation of the same strata is exposed by the curve: such a configuration would result from a spur of concealed granite thrown out towards Tintagel.

The curved line of the beds has been noticed both by Professor Sedgwick and Sir Henry De la Beche, in their memoirs on the Geology of Cornwall and Devon: we thus obtain evidence of a cylindrical elevatory movement affecting these rocks, subsequently to their consolidation, and independent of the phenomena next to be considered.

Cleavage.—The early geologists noticed broad mineral differences only: the next race had to distinguish organic fossils: their successors entailed the further labour of ascertaining the vertical direction of rocks, or the *dip* and the horizontal range or *strike*: the requirements of a higher science now demand that the planes

* Sharpe, Geology of North Wales. Proceedings Geol. Soc., 1842 & 1844.

into which slate rocks divide should also be observed, as well as the direction of the joints and character of the dislocations.*

The effect of the forces which have produced cleavage is curiously exhibited in the Tintagel fossils, which are lengthened in the direction of the strike of the cleavage: we are thus introduced to the study of a new class of phenomena, the first result of which, in the able hands of Mr. Sharpe, has been to diminish the number of species by the removal of certain distorted forms from the list, on its appearing that the variety in their shape is merely a result of cleavage force. Another consequence has been the elevation of cleavage force into a law affecting the great masses of the globe, and evincing a powerful cause of action subsequent to deposition, consolidation, and elevation. The complete consideration of its effects in Cornwall cannot be entered upon without data derived from a far more extended area than the district now under consideration. Mr. Sharpe states, concerning Tintagel,—"The prevailing dip of the cleavage is to the W.N.W. at 10°; in some parts the bedding and the cleavage have been slightly displaced in the same direction. These differences in the angle at which the cleavage intersects the bedding appear to have had an influence on the amount of distortion of the organic remains, as these are usually most altered in form where the angle of incidence of the two planes is the least."†

In the great quarry at Delabole the cleavage-plane is nearly, if not quite, coincident with the bedding. The workmen say that it is quite coincident, but the surface of the beds denotes a low angle.

The valuable law which may be deduced from the observations on slaty cleavage in North Wales—viz., that the slate is only good where the cleavage forms a considerable angle with the bedding, does not appear to be applicable to Cornwall.

Soil.

The soil of the district is different in its character from that lying over the carboniferous series on the north. After leaving the thin

* On Slaty Cleavage: vide Sedgwick, Trans. Geol. Soc., vol. iii. Penny Cyclo., art. Slate. Sharpe on Slaty Cleavage, Geol. Journal, 1846.

† Sharpe, on Slaty Cleavage p. 77.

siliceous retentive surface of St. Gennys and Otterham, we arrive in firmer and deeper land, less permeated with water, less sprinkled with spar, and more congenial to grass. The deep soil of the decomposing greenstone and trappean ash, is as fertile in Davidstow as in Milton Abbott, and from the same causes.

A well defined line of grassy verdure distinguishes this formation through St. Cleather and Davidstow. The waters of this district, forming the source of the Inney, fertilize as they flow, and the narrow meadows near this river possess a richness along its whole course unknown to the clayey lands of the Tamar valley: much bog timber has been observed in the marshes near Davidstow church, though now a few trees around the homesteads are the only representatives of Woodland.

Economical products.

There is no limestone now wrought in the district. The calcareous matter occurring along the line of the greenstone is too intimately mixed with it to be available. The harder varieties of the greenstone furnish excellent materials for roads, and tolerable building-stone is obtained from the more sandy portions of the slate rocks. There are some mineral lodes; one conspicuous in the Delabole quarries, containing lead; another visible in the cliff, near Grower; a third on the top of Boscastle hill; but none have been worked to profit: the chief mineral product is roofing-slate, which is extracted from several quarries along the coast, and from Bowethick in the Trebarwith road, but chiefly from the celebrated Delabole quarries. The history of the last named quarries is given in Sir Henry De la Beche's Report. At the time when he wrote, the only power used besides manual labour, was the horse-whim. In the year 1837, steam power was introduced by Mr. Avery the proprietor, and the consequent increase of production and employment has been so great, that there are now at Delabole five steam engines, and 1,000 persons employed in raising, on an average, 120 tons of slate per day, which is manufactured on the spot into roofing-slates, flooring-slates, cisterns, chimney-pieces, porches, and stone fittings of various descriptions, and exported to other parts of the United Kingdom, to France, Belgium, the

West Indies, and America. The deepest excavation is about 350 feet, and the material is lifted by large kibbles traversing a guide-chain, constituting a kind of flexible railway.

Organic Fossils.

The organisms detected in this district (specimens of which are sent for your museum) are found in and near the good slate; they sometimes occur in the condition of casts filled with earthy matter, but more frequently as sharp outlines of the shell covered with glittering green plates. The following are all hitherto determined.

Polypiaria.

Fenestella (laxa?)	Bossiney.

Crinoidea.

Numerous — undeterminable	Tintagel. Bossiney. Davidstow.

Conchifera Brachiopoda.

*Spirifera gigantea** ..... (Query identical with *Sp. disjuncta.*) Geol. Trans., v., p. 55, fig. 1: Phillips, Pal. Foss., fig. 130: Sharpe, Slaty Cleavage. *Spirifera disjuncta*	Tintagel. Delabole. Lesnewth. Trevivian.
Terebratula (undetermined)	Tintagel.

Cephalopoda Polythalamacea.

Orthoceras (lateralis?)	Tintagel.

The fossils are most abundant in an earthy bed among the slates. The forms are commonly much distorted: the specimens selected by Mr. Sharpe for the illustration of his Paper on cleavage, before alluded to, were obtained from this locality. Fragments of *Spiriferæ* may be seen in the roofing and flooring slates of all the quarries from Grower to Delabole. The brilliant green lustre of their surface usually betrays them, though the outline is rarely complete.

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* One specimen sent is remarkable for adding to our knowledge respecting the true shape of this shell.

This scanty catalogue presents a great contrast to the multifarious lists of the Petherwyn fossils on the one side, and the Silurian forms of South Cornwall on the other; the absence of *Trilobites* and rarity of *Cephalopods* distinguish it from the former, and the entire absence of the remains of fish from the latter. The difference however between these and the Petherwyn is less in genera than in species, and may well consist with them, being contemporaneous deposits.

Relation to other deposits.

Any extended consideration of this would be misplaced in the sketch of an area so limited as the preceding. The inferiority of the whole to the northern carboniferous black limestone, manganese, shales, and grits, though obscured, is yet established. The key to the true position of these slate rocks, with reference to the Silurians of the south coast, will probably be found in an investigation of the strata at Newquay, and around the Padstow estuary, and thence to Fowey, a task which (unless previously accomplished by another hand) I hope to attempt on some future occasion.

Launceston, 23rd Sept., 1847.

Remarks on the present state of the Geology of Cornwall.

By RICHARD Q. COUCH, Esq.,

CURATOR OF THE SOCIETY.

Having, during the past year, had frequent opportunities of examining fossils found in different parts of Cornwall, from the most northern to the most southern and western localities in which they have occurred; and having also, with them, received numerous observations on the lithological characters of the different districts, I am induced to lay the result before the society. There is not much new information to be communicated, but at the commencement of a new volume of our transactions, it has been thought desirable that our present knowledge should be so classified, as to facilitate our future researches. This, until the present year, we were unable to accomplish, and even now it must be very imperfectly done, for a district so disturbed by contortions and disruptions of its strata it has rarely been the lot of the geologist to examine.

At our last annual meeting, a valuable Paper on the Carboniferous deposits of the northern parts of Cornwall was received from Mr. Pattison of Launceston: from his remarks, and from the subsequent observations of others, it is now satisfactorily established that our north-eastern boundary is composed of carbonaceous rocks. The whole of the sea coast, from Marshland mouth on the north to Boscastle on the south-west is formed of this rock, and from thence it stretches across the county, in a south-easterly direction, by Forrabury, Lesnewth, Halworthy, where it runs parallel to the road, over Laneast down, by Piper's pool, Lezant, and from thence it crosses the Tamar, where it is continuous with similar deposits in North and central Devon. The line of demarcation, between this and the Devonian or underlying deposits, is well defined only in very circumscribed spots; for generally they

are so much intermingled and broken by intrusive trap veins and the elevation of the granite ranges, that nothing definite can be laid down. Just where the two deposits unite, there is an injection of a trappean character; but whether it belongs to the Devonian or carboniferous series it is not easy to determine. The slates of the upper beds are soft, thick, and friable, and are quite unfit for any permanent use; while those of the Devonian or underlying series are held in high repute. On the northern shores, the dip of the strata is north at a high angle; but there is no continuous character in this respect. In some places they are nearly perpendicular, in others curved, and frequently they are broken down into a confused mass, or bent into irregular curves. From the small cohesive force existing between the layers of the shales, the act of elevation to their present angle has produced numerous furrows on their surface, from one layer sliding over the other.

The colour and character of the rocks within the area described varies very much. In the most northern deposit the organic remains are chiefly of a vegetable character, having numerous impressions of *Calamites, Sternbergia, Sigillaria,* &c., though very much obscured and injured. They are similar to the coal deposits in Wales. Passing on in a southern and western direction, these vegetable remains disappear, and shells and *fuci* occupy their place: the shells are chiefly *Posidoniæ* and *Goniatites,* showing a sea coast; and as the rocks rising beyond, in a westerly direction, are occupied by fossils indicating a salt-water sea, there is presumptive evidence to suppose that our carboniferous deposits may have formed a sedgy beach; for most of our vegetable fossils are of a sedgy character.

Beyond the edge of these carbonaceous rocks, in a westerly and southerly direction, are found deposits of an entirely different [illegible] are continuous with the rocks outskirting the [illegible] Devon. This series is composed of lime- [illegible] blue, yellow, and claret-coloured slates, in [illegible] from a slight elevation to an entire [illegible] Plymouth, is continued [illegible] found extending east and

west, by Tideford and St. Germans to the eastern side of Looe river; becoming more and more impure as it gets westward: in this are found shells, such as *Bellerophon*, and near Fowey, fish. The slates abound with fossils. At Looe, there are the casts of shells and *Echinodermata*, chiefly in the brown and blue slates, and occasionally also in the red. This or the Devonian series extends along the Looe river by Kilmanorth and Muchlannick, and obliquely through the county, north-westward, by Lostwithiel to St. Columb. The western boundary is not yet ascertained; but after passing the Looe river westward, the Devonian fossils become rarer, and assume more of a Silurian character. The peninsula formed by the Looe and Fowey rivers is composed of rocks partaking of the characters of the Devonian and Silurian series. The fish beds skirting the southern boundary extend so far west as Polruan (where they are abundant), though they are more obscure there than about four miles to the east. In Lantick bay, Mr. Peach has found them in limestone, and in Coombe bay I have found them in the blue slate; but across the river, in the Fowey rocks, they have not yet been discovered. In this small peninsula the rocks are slate, of the blue, yellow, and red kinds, running east and west, and in some localities greatly dislocated and pulverized. The valleys have generally a south-east direction, but at Water Gate, about a mile and a half north of the fish beds, there is another valley running nearly at right angles with the former: at the base of this valley is a stream with a blue clay bed, and to the north the rocks are of a dull yellow colour, soft and friable, and extend with but little variation to Pelynt; these are highly fossiliferous, but the decomposition is so great that the specific characters cannot at all times be determined. At St. Veep, Ethy, Western Taphouse, and Bogga mill in Lanreath, the rocks assume a light brown and grey colour; in these the fossils are obscure in their characters, but *crinoideæ* and corals are found. At Liskeard, Dubwalls, and east and west of these spots, the slates become firmer, and are of a red and grey colour; in these also are found fossils.

The slate rocks in the immediate neighbourhood of the granite, in some localities to the north-west of Liskeard, are evidently

fossiliferous; for although no actual fossils can be detected, yet cavities are frequently discovered in the yellow and grey slates having hollow casts of creatures resembling the shells of the upper Ludlow rocks, especially some species of *Orthocerates.*

As we advance westward from Looe, the characters of the fossils change. There are many things to remind us of the old red sandstone, and yet sufficient to recall the idea of their being the deposits of the upper Silurian rocks: where the two meet is not yet determined. Further west, in Mevagissey bay, and through the headland to Veryan bay, there are thick beds of blue slates and of white quartz, which contain *Orthides* and other obscure remains, which are now considered as indicative of even lower Silurian beds. Sir R. I. Murchison at first considered that our deposits were entirely Devonian, or at the most, that we possessed only upper Silurian equivalents, but when the fossils of our western localities were exhibited to him, he at once pronounced them to belong to the lower beds of that series. Similar remains are to be found in various localities in the centre of the county; but these deposits have been so little explored, that a fine field there awaits the investigation of the members of our society. A few fossil impressions have been found in the slate deposits west of Truro, but so obscure that it is impossible to decipher them. The deposits of the northern coasts are equivalent to those of the southern, but they extend further to the west than those of the opposite shore.

The great confusion existing among our rocks is no doubt caused by the elevation of the granite hills subsequently to the deposit of the surrounding slates. Mr. Pattison, in his remarks on the sequence of the carbonaceous rocks near Launceston, observes that the beds of that locality are unexpectedly complicated by the occurrence of the Yeolmbridge deposits: these strata, he says, contain *Trilobites, Orthides,* and *Turbinolopsis.*—May not these belong to the Devonian or underlying deposits, which have been thrust through the superimposed or carbonaceous beds? Such is very likely to be the case, but a more minute examination is necessary to determine the point.

On the Fossil Geology of Lantivet and Lantick Bays, near Fowey.

By CHARLES WILLIAM PEACH, Esq.,

CORRESPONDING MEMBER OF THE SOCIETY.

Notwithstanding all that has been written on this interesting subject, it appears that the true position of Cornwall in the geological scale is not yet finally settled. It is very probable, as Sir Charles Lemon observed in his last year's Address to the society, that "years may yet elapse before we shall see the whole truth of "its geological history." He further remarks, in the same Address, that "the only question seems to be whether in addition to the "strata of the old red or Devonian age, we have not also some "beds of the upper Silurian group of Murchison," and he adds, "there is, I am assured, no solid grounds for belief that any "portion contains sedimentary matter of the lower Silurian epoch;" these latter remarks may be considered as indicating the state of our geology at the period of our last year's meeting. I had long before felt convinced that both *upper* and *lower* Silurian rocks were to be found in this county, and it occasioned me anything but pleasing sensations to know that my ideas on this head were in open rebellion against the opinions of the most eminent geologists of the kingdom; and although I had the proof in my own hands, —I allude to the identical fossils which have since proved the correctness of this opinion,—I felt that it would be daring presumption on my part to set up my little experience in opposition to the judgment of those master minds, who had so widely, and with such opportunities and advantages, studied the Silurian system, not only in our own kingdom, but in other countries also. How great then was my delight to find that Sir Roderick Murchison, after he had examined some of the fossils I had sent to him in London, declared that Cornwall was *a Silurian county*, and that

"*true Silurian and even lower Silurian rocks existed in Cornwall.*" As my general conclusion was thus declared to be correct, I felt no uneasiness at being wrong in the specific names, &c., for, as I have already confessed, I am sadly ignorant on this head, and more,—I have now no books on the Silurian system to refer to, and little opportunity of getting assistance when in doubt, being so far removed from any society, or kindred spirit, where help might be had.

When describing the fossils for the Synopsis published in the Report for 1844, I felt considerable hesitation in naming them. I then had many little things differing from some of the figures in the "Silurian remains," which engaged my attention, especially the "notched appearance" of the longitudinal ribs of the dorsal fin of the *Onchus*, but as I had no authenticated specimen (neither had I ever seen one) to compare with my own, and as it appeared to agree with the picture in many respects, I set it down as *Onchus Murchisoni*.

It requires a great deal of experience and tact to decide upon the fine distinctions between specimens; so great indeed is the difficulty, that different scientific men have frequently given a different name to the same specimen, even when in a far better state of preservation than any we have found in this county: and the mutilated state of our specimens renders the difficulty so much the greater.

I trust that my most valued friend, the Rev. D. Williams, who is really a most excellent worker and careful observer, when he has been shown the "medals" lately brought to light, will be convinced that ours is a truly Silurian country, and not "intermediate between the old red sandstone and the mountain limestone." Professor Sedgwick says,* that we have Cambrian rocks in our county; why therefore may we not expect, on a more careful examination, to find the lowest beds of the Silurian system, and the peculiar organisms of the Cambrian system, even to the markings of the *Annelides?* Feeling deeply interested in the final settlement of this question, and believing that we have now a fair prospect of seeing the walls of our building gradually completed,

* See Lyell's "Elements of Geology," 1st edit., p. 464.

as so much of the foundation is already laid, I have given the cliffs from a little eastward of West Coombe (below Lansallos church) to the eastern part of Lantick bay (near Pencarrow head) a rather careful examination, and although the district is comparatively small, and I had very little time to devote to it, my reward has been great indeed; for, if I have found nothing particularly new, I have met with much to confirm my opinion as to our geological position, for I have found fish-remains, if not abundant, still in most interesting forms, and in equally interesting situations, and if I enter into a rather detailed account, my apology must be, a desire of supplying an index for those who are willing to work out and finally settle the question of our true position in the geological ladder.

Commencing on the eastern side of West Coombe, the rocks are very much like those of Polperro; they contain a few fish-remains. Proceeding westward, half way between West Coombe and Palace cove, are some veins of limestone nearly at the foot of the cliff and a little above the level of the beach: in these, fish-remains are rather plentiful,* but unfortunately all are broken to pieces: they are quite black where the outer covering has not been worn off, and form a pretty contrast with the light-coloured matrix: where it has been ground off, the internal structure has a honeycomb-like appearance, in hexagonal cells, the walls of which are of a dark colour; the interior is in most cases filled with beautifully white spar,—probably calcareous: these thin seams of limestone are all nearly vertical, and the line of strike by compass is S.E. and N.W. dipping to the N.E.: two of these seams are filled, on their upper side, with these organisms. Tracing these veins back a little to the eastward, into a mass of slates at the base of which they run, they rise through them to at least 20 feet in height, and appear on the upper part like an isolated mass. On the western side of the bay, on the upper part of the cliff, the vein which in the first part of its course is calcareous, becomes trappean, and although the rock freely effervesces with acids *below*, they have no effect on it *above:* it contains similar fish-remains in almost the same abundance as the calcareous rocks, with which it

* See specimens, No. 1.

is continuous. These remains appear as if pressed into the rock for at least an inch, and have the appearance of having been charred. Some are so completely changed, that if found unaccompanied by a few well-marked specimens, they would never be considered to have been of organic origin; the matrix has an arenaceous appearance and is much broken: it is usually of a dark brown colour, and contains small specks of mica. The fossils in these rocks consist of portions of spines of the *Onchus*, and small masses of scales, occasionally in waved lines; and in light-coloured finely-laminated clay slates, resting about two feet on the upper face of these veins, are very small portions of beautifully marked and well preserved specimens of fish-remains: the scales are arranged in waved lines, placed obliquely, and each scale locks in between two, in an alternate manner. These scales are remarkably small, and require a lens to detect their form. Underlying these calcareous and trappean veins about 30 feet of slates occur, in which are abundance of (probably) *Bellerophon*, and a few *Loxonema*:* the original matter is generally completely destroyed, and its place filled with a brown powder, which I think might be used as a pigment. A few additional fish-remains are met with as we proceed westward: the cliffs here are rather low, descending gradually from Lansallos down; the summits are covered with fine siliceous sand, mixed with fragments of rocks, evidently transported.

At Palace cove the cliff becomes more steep: here, in a soft shaly slate, fish-remains are again plentiful, still in thin seams and broken to pieces, but in a good state of preservation, standing out a little in relief from the soft matrix: they consist of similar remains as those mentioned before, with portions of the spiny and tuberculated (shagreen) skin, amongst which are splendid specimens of the broader ribbed *Onchus*.

A little beyond this cove the *Bellerophon* rocks again appear, in which are also calcareous nodules, and in some parts brownish masses of earthy matter, or cavities from which it has been washed out: a few fish-remains are also found in the slate.

* See specimens, No. 2.

In the course of our search, we have passed over a few nearly vertical veins of hard regular rocks, which here become more numerous, and invite serious attention; they are light coloured, hard, and micaceous, and break into thin rhomboidal plates; at Lantivet sanding cove, they become plentiful, and vary from 6 inches to 1 foot in thickness, and *contain a few fish-remains;* * they here rise into a bold cliff and pass off in rather an abrupt manner, forming a high ridge which extends a considerable distance inland. Associated with these are wide layers of hard quartzose rock and soft slates. The former I believe represent the tile-stones of the old red sandstone, for they are finely laminated, and break into thin pieces. Soft claret-coloured slates spotted with light and dark blotches, which have something of a fossiliferous appearance, are intermingled with all the foregoing rocks. On the west side of this cove a few fish-remains are to be seen in a light-coloured slate. The rocks opposite the steep road leading up the cliff are twisted and contorted, and traversed by white quartz veins; beyond these are several wide layers of hard quartzose rocks: we now meet with a series of high and pointed ridges, which run out some distance from the cliff, forming narrow coves and giving the coast a comb-like appearance.

At Bottle cove, the fish-remains are again rather plentiful in veins about 4 inches wide, in softish slates: the tile-stones are plentiful, and a little farther in the strata, appear to be tumbled over; but they soon regain their usual course.

At Trenail cove, under the Coast Guard watch-house, the strata are in great confusion; the slates are hard, and intermingled with thin flakes of quartz, which, when the softer parts are weathered out, render the rocks very sharp, the quartz crushing under the feet like young ice; here I found the last fish-remains in Lantivet bay: they were first discovered by one of the Coast Guard named Lochran, who takes a little interest in natural history. The fish-remains here are so changed that they become very interesting: † the mass in which they occur appears to contain a great quantity of iron: the cellular structure may be observed if examined with a pocket lens: they were accompanied by a beautiful and well

* See specimens, No. 3. † See specimens, No. 4.

marked specimen which was unfortunately broken to pieces in endeavouring to get it out. Hence to the high ridge on the eastern side of the path that leads down the cliff under Pencarra head, the strata are in great confusion; twisted and contorted in various directions, and forming in some parts long ridges of wave-like rocks, the front edges being cut down like a wall, and broken into short pieces vertically, and divided into very thin plates, lying like the partly open leaves of unbound books: the rock is very brittle. The tile-stones are found all along here, with the wide bands of quartzose rocks as before described. Some of the confused rocks are thrown up into oblique and pointed arches, rising 40 or 50 feet into the cliff, showing a considerable upheaving: others again appear as if turned topsy turvey, stretching out for some little distance with their heels upward, like the brick-work of an uncovered sewer.

Descending the foot-path, we find that we enter upon quite a new field: here we have a great quantity of hard limestones "wedged in" amongst the changed slates, intermingled with trappean rocks, in which veins of quartz of dazzling whiteness occur: some of these rocks are stained red, and contain veins of a soft red ochre-like substance; some have a tufaceous appearance, and all appear to have suffered from violent action. The organic remains are abundant, and are in strong contrast with the dark matrix, being preserved in light-coloured carbonate of lime: they consist of corals, *encrinites, orthocerates,* and shells, generally in a very mutilated state; just before reaching the point, large masses of slates have fallen; below, these are filled with similar remains.* Ascending the cliff, the rocks containing the fossils are thrown up at a very high angle, and come to the *grass.*

Pencarra point is one of the most interesting spots I know between Falmouth and Seaton; it extends far into the sea, and forms a bold headland, one side sloping towards Lantivet bay, the other towards Lantick bay: the scenery is very wild: on the apex of the hill the rocks rise in a series of bold and rough stair-like ridges,—their pointed peaks overhanging the sea, and their weather-beaten sides covered with various coloured lichens. From

* See specimens, No. 5.

it you command to the eastward a delightful view of the whole of Lantivet bay bounded by Nealand point; beyond which are the distant cliffs of Seaton and Rame, the Rame-head terminating the view.

Lantick bay is on the west side of Pencarra point, and is much less in extent than Lantivet bay, Black Bottle being its extreme point westward. On the western part of the beach the strata are fossiliferous, and at the extreme point, under the Pleasure-house, the rocks are siliceous and compact, and contain a great abundance of *Crinoideæ* and large shells, some of the latter very large:* the whole of the original matter is destroyed, and its place occupied in several instances by minute crystals of quartz. This hard rock varies very much in colour, being, in different parts, dark red, brown, grey, and white: softer veins of fossiliferous strata, and siliceous masses, are intermingled with the slates. Near to the foot-path which leads down the cliff is a narrow vein of dark-coloured rock, which breaks with a crystalline fracture, and contains *Crinoideæ*, and effervesces with acid; it is very compact and heavy. The cliffs here are bold and high: at the eastern end, the rocks form a platform under the cliff about 30 feet above the level of the beach; those nearest the cliff are very smooth and level: a small cave is rounded out of the cliff, the top, sides, and bottom of which are as smooth as if they had been polished. A short distance from this the slates are beautifully ripple-marked; but as we proceed the scene soon changes, and the rocks are twisted and contorted in all directions; some forming zigzag lines from the top to the bottom of the cliff, others again, a series of steps, leaning forwards toward the sea. In a narrow spot near this confused mass we meet with organic remains *as if fused and turned into iron:* † a small portion of them appear like fish-remains; others are evidently shells. Dark masses of limestone are also wedged in, with beautifully white veins of calcareous spar: behind these in the cliff, in shaly slate, is a quartzose lode,‡ in which are found crystals of lime, malachite, yellow copper ore, and mundic. These rocks have suffered from some powerful agency, and are thrown into most interesting forms: they appear to be a continuation of

* See specimens, No. 6. † See specimens, No. 7. ‡ See specimens, No. 8.

the arched strata on the eastern side of the point in Lantivet bay.

Time has not allowed me to survey carefully any farther; I have however found, from Black Bottle to Punch's Cross, many interesting fossils, a particular account of which, with the result of a farther search, may form the subject of another communication. The large corals from these cliffs, of which I have sent specimens,* are first found on the western side of Black Bottle, and again in the cliff which crops out in the harbour, near Punch's Cross: they are found in layers, with few other organisms mixed with them.

On a review of what I have stated, the following remarks are suggested. The fish-remains are at times found very abundant in thin seams, with trappean rocks at no great distance, if not immediately in contact with them: after these charnel-houses, if I may so call them, very few indeed are met with for a considerable distance, showing that during this apparent scarcity, all was tranquil for long periods, when great deposits took place, and longevity in the inhabitants appeared to be consequent thereon. One circumstance is very striking,—that similar deposits of *Bellerophontes*, &c., in equal abundance, are also found in the same range of rocks, showing also considerable periods of time; but all confined to their own sphere, alternating with the fish-remains, and, like the latter, very rare indeed, except in the veins where the great slaughter took place. A question naturally arises, were these antediluvians *inhabitants of the same water, and at the same time?* if so, it will appear, that the same destructive element had no effect on the one, but destroyed the other, and that the survivor in its turn fell before another element, in which its neighbour luxuriated and throve.

The representatives of the tile-stones—if not the tile-stones themselves—are found under similar circumstances to those found in the lower part of the old red sandstone, and they also contain fish-remains, but have not yet been met with in great abundance; there are also bands of limestone "wedged in" amongst our slates, with concretionary nodules of limestone and silex, all proclaiming the true position of these rocks in the geological scale, which is, if I am not greatly mistaken (at least as far as I can learn from

* See specimens, No. 9.

Lyell's and Hugh Miller's works), *the lower part of the old red sandstone.* I venture therefore now to express my long formed opinion, from a most anxious consideration of the question, that the *old red sandstone* is, as just stated, found at Polperro and Lantivet bay; *upper Silurian rocks* at Fowey, thence to the Gribbon, and in the cliffs as far as the Black-head; and *lower Silurian* at Goran haven, Caerhayes, and Gerrans bay.

I well remember, on finding my first specimen, I mean the dark rocks filled with mica, at the Carn Goran haven, how much I was struck with the resemblance of the *Trilobites,* and especially the *Orthidæ,* to those I had seen from the Silurian rocks of Wales; the absence of the corals, and the extreme rarity of *Crinoideæ,* with the siliceous matrix, were the only things which then appeared puzzling, and could I have supplied a few of the one, and changed the siliceous matrix into calcareous, I should have assigned it a place in the Silurian scale; but in future, whether silex or lime be the matrix, will weigh but little with me, for I have been taught a lesson, by the sudden change in the composition of the veins near West Coombe, and of the fossils into iron at Trenail cove and Lantick bay. I am also more confirmed in the opinion expressed in my previous Papers, of the organic origin of many of the black nodules and carbonaceous markings in our rocks. I fully believe that many of our rocks are fossiliferous, although all trace of the structure of the organisms is obliterated by the powerful and destructive agency—probably volcanic—which has so completely changed, and twisted and torn them into confused masses.

I would just add, that I have also learned by my late excursions that which will help to solve a difficulty I have long experienced, connected with certain objects in *trappean rocks;* and which difficulty I believe will vanish when I next have the pleasure of visiting them.

The specimens accompanying this Paper I beg the society's acceptance of: some of them are very excellent, and I trust they will be considered worthy of exhibition in the museum: the localities are marked on them, and the numbers refer to the places in which they are mentioned:—my most anxious wish for the firm and final settlement of our geological position will probably be a sufficient apology for the length of this Paper.

Since writing the aforegoing communication, I have sent to Mr. Hugh Miller of Edinburgh a few small specimens of some of the remains of fishes from the rocks in Lantivet bay and Polperro, not one of which he identifies with those from the old red sandstone formation of Scotland, neither can he see any resemblance between them and the figures in Agassiz's work on Russia: he says also that "mineralogical character is but an indifferent guide "to the geologist; but we have certainly no such ancient looking "rock in our Scotch Devonian as the grey slate of your envelop-"ing matrix."

It is also worthy of note, that in consequence of fish-remains clearly resembling an *Onchus* having been found in Llandielo flags and the rocks of Bala, the lower Silurian can be "no longer "considered an invertebrate period."

REFERENCES TO THE PLATES.

PLATE I.

Fig. 1. Portions of spines; natural size.

„ 2. The same magnified.

This probably belongs to an *Onchus* and is much like *O. Murchisoni*. From Lantivet bay; rare.

„ 3. A beautiful delicate spine.

„ 4. Part of the same magnified: the upper part is split, and shows the tube which runs through the centre. From Polperro; occasional.

„ 5. Probably scales.

„ 6. The same magnified.

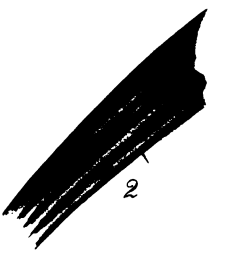
This is the only specimen I have seen: it very much resembles the scales of the *Chieracanthus*. The longitudinal markings are wanting in mine, owing to the specimen being weathered. From Polperro.

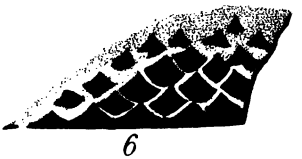
„ 7. A fragment of (apparently) a jaw; natural size.

Lantick bay; not common.

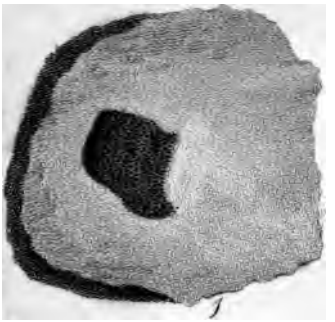
Plate I.

a





C.W. Peach pinx.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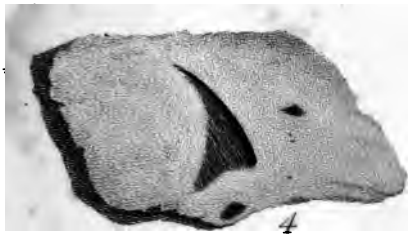
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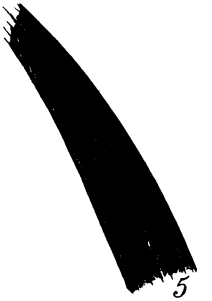
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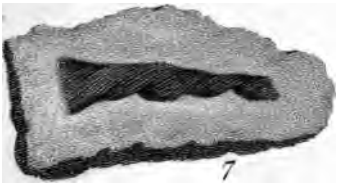
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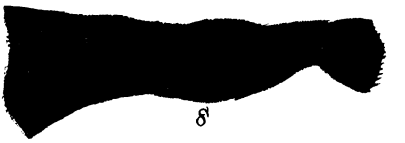
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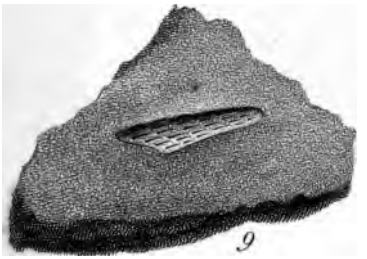
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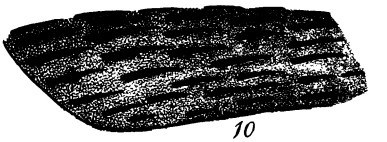
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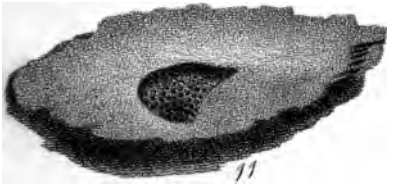
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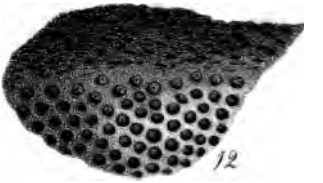
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C.W. Peach pinx.

W. Willis sc.

PLATE II.

Fig. 1. Scales; natural size.

„ 2 & 3. The same magnified.
From Lantivet bay; very rare.

„ 4. A portion of (probably) a fin; natural size.

„ 5 & 6. The same magnified.
From Lantivet bay; very rare.

„ 7. A striated piece of fish; natural size.

„ 8. The same magnified.
From Lantivet bay; not uncommon.

„ 9. A small piece with prostrate spines.

„ 10. The same magnified.
From Lantivet bay; rare.

„ 11. A small tubercled specimen; natural size.

„ 12. The same magnified; showing that the tubercles, when rubbed, have a black centre, with white between it and the outer rim, which is also black: when not ground down the tubercles are black, and rounded on the top.
From Lantivet bay; very rare.

Notice. On a Stump of a Tree found in cutting a Drain at Heligan.

By Sir CHARLES LEMON, Bt., M.P., F.R.S., F.G.S., &c.,

PRESIDENT OF THE SOCIETY.

When I was lately at Heligan, Mr. Tremayne shewed me a stump of a tree which had been uncovered in cutting a deep drain in one of his fields. The drain was near the foot of a hill; but many feet, perhaps 20, above the level of the little stream at the bottom of the field. Higher up, is another drain, perhaps 40 feet above the stream; and generally speaking the strata are the same in both. Where the stump was found, the strata presented these characters: first, 20 inches of loam; then a black band, apparently coloured by some vegetable substance, but shewing only mere threads or fibres, which may have been roots of marsh plants: under this, to the bottom of the drain, is a mass of clay and broken slate, the latter being very friable, and generally in extremely small fragments, and the former being either white, or blue, or yellow, and sometimes with a tinge of red. The stump was about 4 feet long, and nearly one foot in diameter: it lay somewhat inclined, and without roots, its lower extremity being about 7 feet 4 inches from the surface, and resting on hard ground. The upper extremity appeared to have been fractured; and the grain of the wood, which is very apparent, evidently shows that the tree was oak, now blackened by the usual effect of water. In some places, the bark still adhered to the tree, or to the clay from which it was removed.

The problem to be solved is, how did the stump get there? and by what means was the thick mass of debris accumulated over it?

In the solution of this problem, these questions suggest themselves:—Is there, in the circumstances of the surrounding country, any symptoms of natural causes, sufficient to account for this accu-

mulation of material? and secondly, if we are driven to extraordinary causes, do the effects seem to lie within the limits of diluvial action?

The impression on my mind is adverse to both these suppositions; and I can account for the phenomena only by supposing that changes in the face of the country have taken place since the great deluge, great in their effect, though perhaps covering only a small area.

First, as to existing circumstances:—

It is inconceivable that the little stream which now drains that country should ever have swelled to a size necessary to transport the vast quantity of debris which is now accumulated on the side of the hill where the fossil tree lies. And if we imagine the occurrence of one of those partial or local floods which have sometimes produced vast accumulations of clay and gravel, the difficulty is hardly less; for we must suppose that a thick deposit of alluvial matter has been left on the side of a wide and deep valley, which on this supposition must have been filled almost to the brim.

The diluvial theory has difficulties of another kind, but I think not less insurmountable. Amongst the debris, I could find no trace of running water; no rounded pebbles, or beds of gravel; and the deposit itself did not seem to contain anything which might not have been derived from the neighbouring hill. Clay abounds there, and killas of the same soft and rotten substance, often silky, and sometimes almost talcose. Had this accumulation taken place by the force of a general flood sweeping down from the mountains in the neighbourhood, it is hard to believe that it would not have brought down from thence some fragments of the granite or hard killas with which they abound, and that we should not have found these fragments rounded and imbedded in the softer materials of the valley: of such, however, I could find none.

Casting aside these two hypotheses, I can invent no other, except that there has been an entire change in the form of the land since the great thickness of detritus which I have described was laid down. But to pursue this idea would take me into a wide sea of conjecture, and I should soon lose sight of land in my endeavour

to account for all the phenomena which present themselves. That great movements (elevations or depressions) may have taken place in this spot no one can doubt: they can be traced along the coast in various parts of the county, by submerged forests and raised beaches; and there is no reason to think that such movements were confined to the shore. I can imagine the existence of a set of circumstances, now no more, which would have made the whole of the marshy bottom, and the low hill on the side of which the tree was found, a lake: but there are no data by which to fix its limits or determine the mode by which it was broken up. Other drains in other parts of the valley may at some future time supply these data; and till we possess them I am content to record the facts of the case and restrain my desire to account for them. I therefore draw no inference from what I have seen, except that the deposition of clay and slate proceeded from a local and not a general cause;—that it occurred after the growth of trees of existing species, and before the known divisions of the land; and that it must have been at some very remote period; because the thickness of the loam on the surface, being formed by a slow process, must have required many ages to accumulate; and according to any hypothesis, the gathering of the detritus must have been complete before this process began. I could find no trace of a shell in the mud.

On the rapid diminution of the Sand-banks in Mount's-Bay.

By RICHARD EDMONDS, Jun., Esq.

The great extent in former periods of the sand-banks on the east and west of Penzance, has been already noticed in the Transactions of this society.* These banks, so recently as within the last fifty years, presented on the sea side of the high road two beautiful walks of green turf, varying in breadth from about 40 feet to nearly as many fathoms—the one stretching more than two miles between Penzance and Marazion, and the other one mile from Penzance to Newlyn—each being continuous with the exception of an occasional opening for communication with the beach.

Seventy years ago a meadow lay outside the present sea wall at the entrance to Newlyn; and about the same period were several houses and gardens in Penzance seaward of the cottages at "Sandy-bank;" but of these extremities of the old "Western Green" not a vestige is now visible. A minute description of what remained of the western bank in 1826 was given in the third volume of the Transactions.† In order to preserve the portion still left within the limits of Penzance, the Corporation in 1843 completed a strong wall, forming the sea side of a noble terrace-walk or esplanade, half a mile in length, which promises to be a permanent barrier against all further encroachments of the sea. The eastern bank is also rapidly diminishing, but no sea-wall has yet been required. Numerous rocks, lying between high and low water, which forty years since were always buried 4 or 5 feet beneath the sand, are now uncovered: this applies to the beaches below both sand-banks, and is particularly observable near Newlyn, Chyandour, and Marazion.

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* Vol. ii., p. 136. † p. 167.

The effect of this disappearance of the sand, and of the consequent deepening of the water along shore, is very remarkable at the causeway leading from Marazion to St. Michael's Mount. This causeway, or ridge of shingle and sand, is evidently formed by the confluence of the waves coming round the Mount from the east and west at every tide. Three hundred years ago, Leland observed that "the passage to the Mount from the main was six "hours open" out of the twelve—and so it continued for 220 years afterwards without "the least alteration."* But within the last eighty years a very sensible change has been effected; for at present the passage is open only four hours out of the twelve, and frequently, at neap tides, during the prevalence of strong S.W. winds, the causeway remains covered for days together. This change in the period of the Mount's insulation from half to two-thirds of the day, appears to be owing to the removal of the sand that adjoined and supported the western side of the ridge, which has consequently lost much of its elevation, and is therefore covered proportionally earlier every tide. Another effect produced on the causeway from this removal of the sand and deepening of the water on its west, is that it has been bent or shifted, near the centre, many feet further towards the east than it was forty years ago.

Some suppose that the action of the waves has been the chief cause of the disappearance of our sand-banks, and doubtless it has often, during storms, undermined and prostrated large portions, and carried out considerable quantities of beach beyond the line of low-water; but in the course of the year the sea always deposits on the shore much more than it withdraws. The great cause of the lessening of the banks appears to be the constant abstraction of the adjacent sand and pebbles, between low and high water, for manure, ballast, road-making, building, and other purposes. Some idea of the vast quantity taken for manure may be gathered from the fact, that a very usual clause in farming-leases in this neighbourhood is, that ten butt-loads of sea sand shall be spread on every acre whenever it is broken for tillage: and the sand is often

* "Natural History of St. Michael's Mount, by the late ingenious Mr. Price, of Penzance," quoted in Polwhele's Cornwall, i., p. 153.

carted away over a hilly country to farms five or six miles from the coves which furnish it. The quantity used for ballast must be also very great, as Penzance is a place of considerable trade, and the *exports* of merchandise are very little compared with the *imports*. That the cause now assigned is the true one is confirmed by the fact already mentioned, that no diminution in the height of the shoal between the Mount and Marazion had taken place for 220 years after the time of Leland, during which period there was but little agriculture or commerce in the bay.

Thus the sands, which in some neighbourhoods accumulate in the sea to the great peril of mariners, have here been deposited on the shore, where for centuries they have served as pasture grounds or pleasant walks, and as barriers against the sea, but have latterly proved still more valuable for agricultural purposes. Husbandmen are aware that the soil from one district on being distributed over another proves oftentimes highly beneficial to the latter. When, for example, fragments of granite are washed down into the bay, reduced to sand by the action of the waves, and then spread over a killas stratum, they tend greatly to its fertilization, and *vice versa*. Thus, in the great geological laboratory, during the lapse of ages, manures of various kinds—calcareous, silicious, and argillaceous—have been prepared, without the least expenditure of human labour, and are treasured up on our coasts to be used on the neighbouring farms in any quantities that may be required.

Penzance, October, 1847.

On some Post-tertiary Deposits in Cornwall.

By S. R. PATTISON, Esq., F.G.S.,

MEMBER OF THE SOCIETY.

It will be a useful labour at some future time to review the whole of the recent deposits in this county, and in order that this may be effectually done, a series of short communications may not be unwelcome from the members, descriptive, as well of the instances already known, as of those newly discovered. This investigation in Cornwall is more attractive than elsewhere, from its disclosing the former existence of forests in places now conspicuously barren, and also from the relics of ancient mining operations associated with some of the beds. The interest felt by a *few* for the remains of early organic life, is here superseded by the attraction for *all*, raised by the haunts and employments of our own remote ancestors. The changes which have taken place since the historical era may, if thus chronicled, afford us a measure of geological time, and an estimate of the power of present forces.

Whilst alluding to this, I may be allowed to state that it will be an object not unworthy of our attention to secure also the details of remarkable floods.

The storm of the 9th of July last, which fell along the high land from Michaelstow beacon to Warbstow burrow, will leave permanent records of its ravages in field and flood. The immediate effects on the summit were the formation of gullies and deep pits, torn out with perpendicular sides like graves, shewing that at some points the rain descended with the eroding force of a cataract. In the course of two hours there were extensive accumulations of detritus in high levels and cavities, the rivers Camel and Inney became suddenly enlarged to an unrecorded extent, the banks were destroyed, the course of the streams altered, additional channels

formed, and valleys raised by transported shingle. Lower down the streams than where the rain fell, the flood came in one large wave of transport, carrying boulders of several tons weight, and ripping out fences, soil, and even solid rock. I noticed at the mouth of the Inney angular water-worn fragments of all the rocks on its banks from Davidstow downwards. The rate of transport, the duration of force, and the extent of rounding process, would form materials for reasoning on the power of causes, at present in operation, to produce the phenomena now visible around us.

1. *Submarine Forest at Bude.*

In my communication of last year, I referred to the existence of a layer of trees under the present beach at Maer, near Bude. The effect of the surf in April last laid bare a portion of this deposit, and the following notice respecting it appeared in the West Briton of May 14th :—

"Discovery of Antediluvian Relics.—Recently, at Maer "Lake, near Bude Haven, there has been discovered between high "and low water mark, a great quantity of soil, to the depth of "20 feet, which is covered by the sea every tide. Many farmers "have been drawing it away for manure, in preference to sea sand; "and there have been found imbedded large trees, of enormous "size, quite sound; a bullock's horn, which measures 4 feet long, "and 18 inches in circumference, and a large stag's horn, 5 feet "long, and of an enormous size. T. Carnsew, Esq., of Flexbury, "has manured his grass lands with the soil, and it has had a very "surprising effect."

I am informed that the trees and horns were not above the ordinary size, and that the fertilizing property of the soil has also been over rated. Some of the wood collected by me on the spot accompanies this Paper. There were roots as well as trunks, the former apparently in the place of growth, in a bed of dark clay.

2. *Valley of the Fowey.*

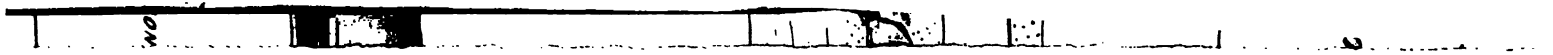
The stream-works in the valley of the Fowey, on the Bodmin moors, have disclosed at various times large accumulations of bog timber. The wood thus discovered has been commonly used by

the tinners: I have seen it in large piles near Bolventor. In the instances noted, the heads of the trees have been directed down the valley, as though they had been overthrown by a sudden northern drift whilst in full leaf and vigour, and not transplanted far from the place of their growth.

We are indebted to Mr. William Daniel, jun., of Liskeard, for the accompanying excellent Drawing of a peat deposit recently opened in this valley. An inspection of it shews that twice has the surface been clothed with vegetation. The first time, on a granitic soil, grew large timber trees: a flood laid them down, and spread a layer of granite pebbles and tin over them: another soil was formed supporting a vegetation of bushes and fern, the resort of the deer, and upon this a finer gravel, the result of slower and longer diluvial action, accumulated: and lastly, on this, a third bed of peat has arisen, crowned with no leafy honours, and whose tallest plant is the low but elegant heath.

There is a fault indicated in the drawing, which, if it be an actual dislocation, and not merely a joint and ledge in the rock, indicates a movement in the granite subsequent to the deposit of the first layer of peat; but as I have not verified this by observation, I do not at present seek to raise this inference.

September, 1847.



Notice of certain peculiar circumstances in Gwinear Consols and Wheal Seaton Mines:

Reported to the President by W. W. RUNDELL, Esq.

Gwinear Consols Mine.

This is an old mine, no record of the working of which is known to exist, but it is now in course of being re-worked: it has not yet been worked below the deep adit level, a depth of 23 fathoms. The principal lode, called Heywood's lode, is in a hard dark blue slate or killas, and underlies to the north about six inches in a fathom: it is generally about 2½ feet wide; in some places, however, it extends to 2 or 3 fathoms, and in one place to so much as 6 or 8 fathoms, though it is uncertain whether another lode does not join it at this place. About 20 fathoms south is an elvan course slightly inclined towards the lode, and which intersects it about 200 fathoms to the west, in Old Relistian mine. Both elvan and lode near this place are *heaved* by a "champion cross-course" of spar, with a *flukan*,—together about 4 fathoms wide, and underlying a little to the east. There are several slides in the neighbourhood, both to the east and west of that part of the side from which the specimens were taken, but as far as the present captain is aware there are none at the spot. The lode towards the east appears to consist of a conglomerate of small pebbles and angular fragments of slate, with a few pebbles of elvan: further west it consists of angular fragments of slate mixed occasionally with large pebbles of elvan, more or less rounded, some exceeding 30 or 40 lbs. in weight: the lode contains besides, spar, pyrites, yellow and black copper ore, tin, &c., with a rich-looking ochry *gossan*, in some places reaching down to the deep adit. In some instances the fragments appear to be joined together by a deposition of quartz, and in the mass appear a number of *vugs* or vacant spaces of different sizes; but generally the binding matter seems like a half-formed slate without any appearance of lamination. Near the

slides, masses of slate are found of a very soft nature, evidently of a laminated structure, but breaking almost as readily in one direction as another. No. 7 is a specimen, but it has been injured in the carriage. In the cross-course (the *flukan*) before mentioned have been found granite pebbles resembling the Crowan granite, but as far as I can learn none have been found in the lode: a short distance east, however, of the cross-course, there is a granitic dyke about a foot wide which crosses the lode. The pebbles, &c., found in Relistian mine (mentioned by Mr. Carne in vol. 3 of the Transactions of the society) and cemented together by a "chloritic substance," were very probably found in the same lode that is now being worked at Gwinear Consols. I am also informed that pebbles are found at Alfred Consols, to the west of Relistian, and also in a lode a few fathoms to the north of that from which the specimens were taken. I had some large elvan pebbles brought up, but they were much too heavy to bring away as specimens; if any interest attaches to them they may be obtained at any time. Specimen No. 1 will illustrate the nature of some parts of the lode near the surface. This part is very friable, and it is difficult to get a piece sufficiently firm to be handled. Nos. 2, 3, and 4, are from the 23 fathoms adit, and are very firm in texture. Nos. 5 and 6 are from near the same spot. A great number of the large elvan pebbles have been used for paving and building: they are much harder and of a different texture from the elvan course before mentioned.

I may perhaps be allowed to observe, in conclusion, that an examination of this and the neighbouring mines would be likely to repay the geologist and mineralogist, and would probably, after careful inspection, throw much light upon the subject of the filling up of those fissures in the crust of the earth, known as mineral veins.

Wheal Seaton Mine.

The principal lode of this mine also traverses the sett of North Roskear. From the plan at the latter mine, I find that this lode is a very irregular one, though its general direction is such as to give it the name of a *caunter*. After it leaves the sett of North Roskear, it traverses part of that of Wheal Seaton, and is then

heaved to the right by a great cross-course (a flukan). After passing the cross-course, the workmen drove north to find the lode, and after driving 10 feet they cut one that was considered to be the lode they sought; but as this was an east and west lode, others thought the right lode was yet further north. About 14 fathoms further on, another lode was cut: this was a contra or *caunter* lode, and was pronounced by several mining captains of great experience to be the lode they were in search of. Captain Raby alone was of a different opinion: the quality of the ore was not the same, and although this lode was a large one, it did not correspond sufficiently with that on the other side of the cross-course; he therefore continued driving further north, and had proceeded some distance, still carrying traces of the *heave* with him, when it was thought to be highly imprudent in him to go further; but so convinced was he that he should thus find the right lode, that he offered to prosecute the search at his own expense, and by the wish of Mr. Tilly, the principal adventurer, he was allowed to proceed, and 18 fathoms further north, he found what he considered to be the true lode: it corresponds with that on the other side of the cross-course, and has already produced a large share of the riches which have made this mine so famous.

Produce of Lead Ore and Lead in the United Kingdom, for the Years 1845 *and* 1846; *from Returns made to the Mining Record Office, Museum of Practical Geology.* ROBERT HUNT, Keeper of Mining Records.

Communicated by the PRESIDENT.

THESE returns have been obtained, in most cases, from the parties immediately connected with the various mines, and from the published ticketing papers. As there is no regular publication of the Lead sales, and as the ores are sold in large and small parcels, sometimes publicly, but often by private contract, there has been much difficulty in obtaining accurate information of the entire produce of the United Kingdom. We have more particularly to acknowledge the very important assistance of Mr. John Taylor, jun., from whose knowledge of the subject the following returns acquire a value for correctness, and a close approximation to the absolute quantities of lead ore raised, and lead smelted, which they would not otherwise possess.

We are also highly indebted for the promptitude with which returns and information have been furnished by Messrs. Walker, Mr. Sopwith, Mr. James Barker, of Bakewell, Mr. Percival Johnson, Mr. Davy, of Redruth, Messrs. Williams, of Scorrier, and Mr. Pattinson.

It being desirable that correct accounts of all the mines of lead and silver should be regularly published, it is hoped that the several parties who are connected with lead mines and smelting works will furnish to the Mining Record Office the returns for the present year as early in 1848 as possible.

It would appear, from the inquiries which have been made, that the produce of merchantable lead from the ore throughout the kingdom averages about 68 per cent., and that from 7 to 8 ounces of silver is the average quantity at present procured from the ton of lead. In many instances the quantity of lead ore raised has alone been furnished us, in others only the amount of lead smelted; in both cases we have computed, with as much care as possible, the lead and the lead ore.

TABLE,
Showing the Total Quantity of LEAD ORE RAISED and LEAD SMELTED in the UNITED KINGDOM.

	LEAD ORE.		LEAD.	
	1845	1846	1845	1846
	Tons.	Tons.	Tons.	Tons.
England	54,158	51,984	36,775	35,565
Wales	16,412¼	14,958¼	11,014½	10,015½
Scotland	1,173	1,161	901	942
Ireland	1,577	1,327	585	561
Isle of Man	2,259	2,316	1,523	1,663
Total	75,579¼	71,746¼	50,798½	48,746½

PRODUCE of LEAD ORE and LEAD in the UNITED KINGDOM, for the Years 1845 and 1846.

COUNTY.	MINES.	Lead Ore Returns.		Lead Returns.	
		1845	1846	1845	1846
ENGLAND.		Tons.	Tons.	Tons.	Tons.
Cornwall	Callington	950	1,138	570	683
	Huel Mary Ann	..	166	..	100
	Cornubian ..	420	..	252	..
	East and West Haven.	16	..	9	..
	Huel Trelawney	280	529	168	316
	Camelford	180	..	108	.
	East Huel Rose ...	7,883	5,191	4,729	3,114
	Cargol ..	55	306	33	183
	Oxnams	..	188	..	113
	Huel Rose	57	375	34	224
	„ Penrose	116	11	69	7
	Holmbush ..	..	12	..	7
	New Quay	73	..	43	..
	Porthleven	80	82	48	49
	Pentire	..	34	..	20
	Cubert ..	..	136	..	81
	Leman	..	30	..	18
	Huel Concord	..	30	..	18
	Carried forward ..	10,110	8,228	6,063	4,933

Produce of Lead Ore and Lead in the United Kingdom, for 1845-6,—*continued.*

COUNTY.	MINES.	Lead Ore Returns.		Lead Returns.	
		1845	1846	1845	1846
		Tons.	Tons.	Tons.	Tons.
	Brought forward ..	10,110	8,228	6,063	4,933
Devonshire	Tamar	1,454	1,182	944	768
	Huel Betsey ..	296	58½	148	29
	„ Adams	59	33	29	16
	East Tamar Consols ..	..	114	..	74
	Combmartin	174	213	104	127
Cumberland ..	Alston Moor Mines ..	6,837	6,418	4,615	4,330
	Roughtingill	175	..	87	..
	Driggith Beck Waste.	21	3¾	10	2
	Dry Gill Mine	..	12½	..	6
	Driggeth Mine	74	36	37	18
	Cumberland	25	..	12	..
	Greensides ..	1,430	1,560	1,100	1,200
Durham & Northumberland..	Mr. Beaumont's Mines.	12,200	12,000	8,130	8,000
	Tweedale Mines	2,168	2,128	1,450	1,414
	Weardale do.	560	560	372	372
	Sharnberry (Durham).	88	64	58	42
Westmoreland ..	Dufton .. / Hilton ..	480	480	320	320
Derbyshire	Sundry Mines	7,280	7,280	5,600	5,600
Shropshire	Snailbeach	3,000	3,852	2,100	2,700
	Grits and Gravel ..	300	298	220	219
	Bog Mine	220	230	150	155
	Pennerly	31	100	23	65
	Round Hill	..	11	..	8
Somersetshire ..	Mendip Hills ..	..	4	..	3
Yorkshire	Swale Dale .. / Arkendale ..	4,257	4,257	3,275	3,275
	Grassington	1,358	1,313	816	788
	Cononley	631	663	414	436
	Pately District ..	930	886	698	665
	Buckden	..	..	..	..
	Total	54,158	51,984¾	36,775	35,565

Produce of Lead Ore and Lead in the United Kingdom, for 1845-6,—*continued.*

COUNTY.	MINES.	Lead Ore Returns.		Lead Returns.	
		1845	1846	1845	1846
	WALES.	Tons.	Tons.	Tons.	Tons.
Cardiganshire ..	Lisburne Mines	2,492	2,650	1,623	1,722
	Llancynfelyn	..	4	..	2¾
	Bwlch-yr-esgair ..	30	..	20	..
	Caenant	10	..	6½	.
	Brynglas	10	..	6½	..
	Cwm-ystwyth	356	588	238	382
	Pen-y-banc ..	24	..	15	..
	Llewy-rhog	48	..	30	..
	Esgair-hir	41	110	26	71
	Cwm-sebon	197	250	128	168
	Penrhiw ..	46	..	27	..
	Llanfair	158	242	103	157
	Goginan	1,768	1,558	1,149	1,013
	Gogerddan Mines	210	118½	136	77
	Pen-y-cefn ..	36	46	23	29
	Tal-y-bont	25	..	16	..
	Nant-y-creiau	120	57½	72	33
	Cefn-cwn-brwyno	72	75	43	45
	Llwyn-malys ..	60	..	39	..
	Bwlch-cwm-erfin	23	20	15	13
Carnarvonshire ..	Llanrwst	..	113	..	67
Carmarthenshire .	Nant-y-mwyn	622	659	404	427
	Llanfurnach ..	15	..	9½	..
Denbighshire ...	Llangollen	..	26	..	17
Flintshire	Tarlargoch	1,955	1,308	1,319	882
	Fronfownog ..	125	33	87	23
	Hendre ..	594	918	416	642
	Longley	230	55	161	38
	Maes-y-safn	1,069	1,296	750	907
	Pen-yr-henblas	822	911	575	637
	Gayer ..	18	..	12	..
	Mold Mines	1,078	296	726	198
	Long Rake	76	81	51	54
	Milwr	330	139	223	94
	Pen-y-bryn ..	156	31	109	22
	Dingle and Deep Level.	790	517	553	361
	Carried forward ..	13,606	12,101¾	9,111½	8,081¾

Produce of Lead and Lead Ore in the United Kingdom, for 1845-6,—*continued.*

COUNTY.	MINES.	Lead Ore Returns.		Lead Returns.	
		1845	1846	1845	1846
		Tons.	Tons.	Tons.	Tons.
	Brought forward ..	13,606	12,101¾	9,111½	8,081¾
Flintshire	Pant-y-pwllgwr	..	18	..	12
	Parry's Mine	143	132½	99	92
	Trelogan	94	25	63	17
	Westminster Mines ..	967	819	676	573
	Wainlas	34	35	24	24
	Halkin Hall	133	118	92	81
	Pantyrhys	..	12	..	8
	Carreg-y-boeth ..	..	11	..	7¾
	Afon-gôch	..	62	..	40
	Bodle-wyddan	..	25	..	17
	Belgrave	..	305	..	213
	Brintail ..	45¼	84½	31	59
	Tyddyn-gwydd	57	..	40	..
	Bryngwriog	103	27	72	19
	Holywell	16	..	10	..
	Maes-lygan ..	37	..	24	..
	Jamaica	..	33	..	21
	Mines under 10 Tons .	147	180	94	109
Montgomeryshire.	Llangynnog	115	103	74	66
	Delife	586	557	383	361
	Cae-conroy	73	34	47	22
	Rhos-wydol ..	..	52½	..	34
	Dwngwin	25	..	16	..
	Gorn	33	43	21	28
	Pantmawr	48	..	29	..
	Nantmelyn ..	..	..	..	..
	Craig-rhwarth	..	30	..	20
	Brindail	130	150	96	110
Merionethshire ..	Portmadoc	20	..	12	..
	Total	16,412¼	14,958¼	11,014½	10,015½
	SCOTLAND.				
Ayrshire	Wood Head	509	480	424	400
Dumbartonshire .	Dumbarton	269	..	161	..
Kircudbrightshire.	Cuernsmore ..	..	20	..	13
Lanarkshire	Lead Hills Mine	395	661	316	529
	Total	1,173	1,161	901	942

Produce of Lead Ore and Lead in the United Kingdom, for 1845-6,—*continued.*

COUNTY.	MINES.	Lead Ore Returns.		Lead Returns.	
		1845	1846	1845	1846
IRELAND.		Tons.	Tons.	Tons.	Tons.
Clare	Kilbricken	102	38	66	25
	Ballyhicky	119	32	83	22
Down	Newtonards ..	433	211	280	137
	Conlig	100	65	65	42
Limerick ..	Limerick	12	..	8½	..
Monaghan	Bond and Newry	21	44	13	29
Wicklow	Sundry Mines ..	93	240	56	144
	Luganure	457	405	..	..
Waterford	Barristown	22	250	14	162
Wexford ..	Caime	218	42	..	..
	Total	1,577	1,327	585½	561
ISLE OF MAN.					
Isle of Man	Foxdale Mines, including Peel's Shipment & Beckwith's Vein..	1,902	2,071	1,283	1,498
	Laxey	327	155	220	104
	Douglas	..	80	..	54
	Mona	30	10	20	7
	Total	2,259	2,316	1,523	1,663

LEAD ORE and LEAD IMPORTED and EXPORTED.

Years.	IMPORTED.				EXPORTED.			
	Lead Ore.		Lead.		Lead Ore.		Lead.	
	Tons.	Cwts.	Tons.	Cwts.	Tons.	Cwts.	Tons.	Cwts.
1843	68	16	2,775	0	176	9	14,610	14
1844	95	9	3,058	0	257	3	14,697	0
1845	444	3	5,209	17	169	1	10,485	8
1846	724	1	7,862	12	53	13	6,421	15